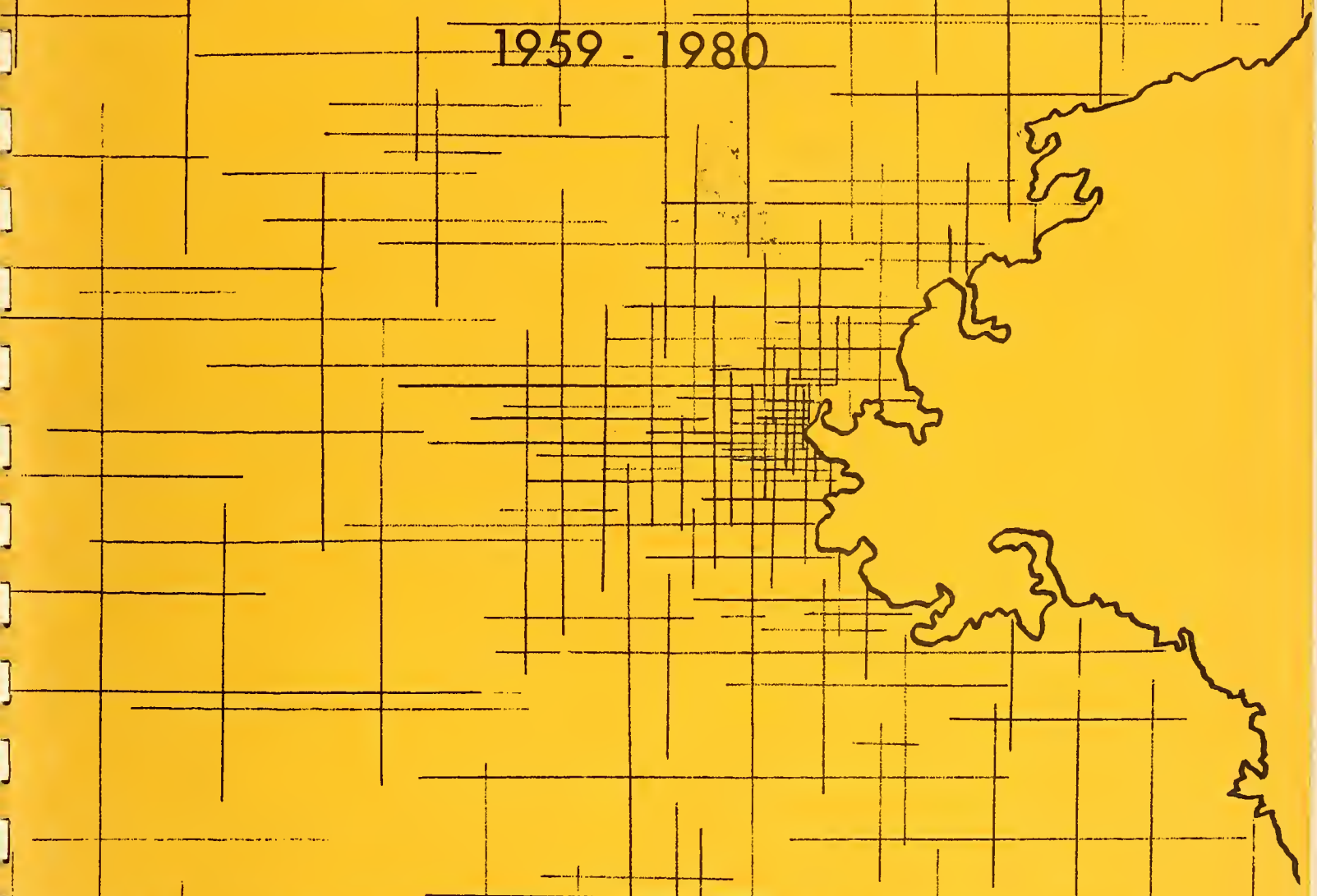
STUDIES OF URBAN TRANSPORTATION

TRAVEL IN THE BOSTON REGION

1959 - 1980



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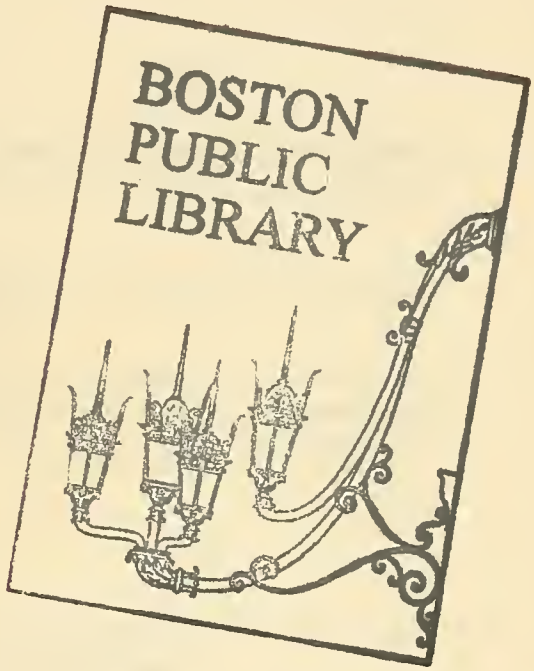

SEMINAR RESEARCH BUREAU BOSTON COLLEGE

January 1960

STUDIES OF URBAN TRANSPORTATION

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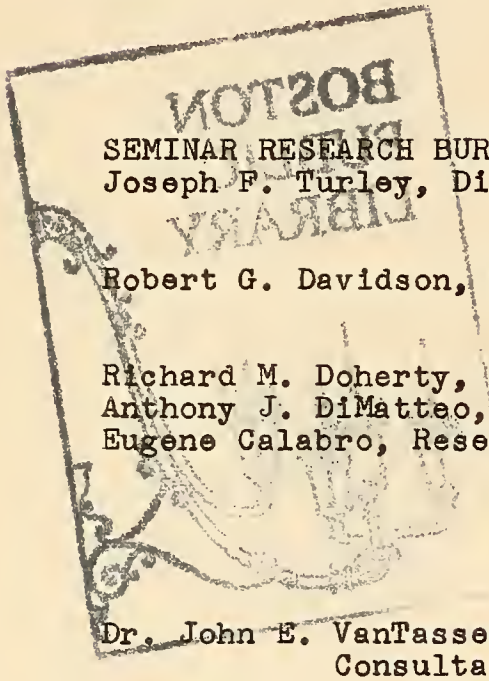

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STUDIES OF URBAN TRANSPORTATION

SEMINAR RESEARCH BUREAU COLLEGE OF BUSINESS ADMINISTRATION

BOSTON COLLEGE January 1960

SUMMARY

Transportation is always in a state of crisis. The agencies charged with finding solutions to the problems constantly find themselves using yesterday's data to solve yesterday's problems. Unfortunately the solutions must be financed with tomorrow's income and financial resources.

This series of reports will forecast the travel condition that will prevail in Regional Boston in the future. Although many forecasts have been made this one differs in that it is based on factors and relationships that have been proved to be related to the underlying generators of travel demand. It is based on a thorough and detailed study of these factors. The statistically sound limits of error are stated so that the administrator knows exactly what the possibilities of error are. The derivation of the factors is given so that with new information reflecting changed conditions, the forecasts can be easily adjusted.

The technical importance of this material is that it provides a method by which transportation facilities can be constructed with maximum insurance that they will meet the needs of the future as well as the known demands of the present. A working model of Metropolitan Boston transportation has been created which allows forecasts of

not only the volume of travel but the purposes for which trips will be made, the method of travel, and the places where the trips will originate. Such complete information on travel has never before been forecast for the Boston Metropolitan area. It will allow the accurate planning and construction of not only highways, but transit facilities and parking facilities. The model that has been constructed can be continually used as a forecasting and planning device at a minimum expenditure of governmental money.

This report is also significant in that it is one of the few comprehensive and detailed studies of transportation needs that has ever been made by a private organization without the use of public funds. It represents an extension into a new area of the privately sponsored governmental research movement. It opens up the possibility that private organizations can cooperatively plan with government even in those areas where the superior financial resources of governments have heretofore barred technically competent participation. It demonstrates that even in study operations sound planning and management can reduce costs greatly. Careful design, creative use of existing tools, and utilization of studious interpretation of results have succeeded, in this case, in reducing costs in the area of transportation planning. This is a significant acomplishment in that these costs have tended to increase greatly

in recent years.

The study and resulting model are based on a sample survey of the travel habits of 1000 families in the Boston Metropolitan area. This is much smaller than prior samples used for this purpose. However, most of the results are of an accuracy comparable to those obtained from the larger surveys. Rather than developing basic information in every aspect of travel, this survey was used to adjust to finer accuracy the information on travel habits that is already part of the store of knowledge in transportation engineering. Thus unnecessary repetitive processing and analysis were eliminated. This refined data then was used to construct equations or mathematical models dealing with travel habits. These equations incorporated in them not only the present travel habits of Boston families but automatic adjustments for the changes that are taking place in these habits. Information on the future location of population was then developed and application of the formulae to these populations resulted in accurate forecasts of the origins, purposes, time, mode and volume of trips. This much is presented in this report. Future reports will provide estimates of the destinations of trips and will utilize all of the information to indicate future over-all needs, timing, and priorities for highway, mass transportation and parking facilities. It will allow, also, the development

of general guides to the most desirable patterns of economic and population development.

The method and information provided in these reports, it is confidently desired, will open up new possibilities in allowing transportation administrators and those with responsibility for participation in transportation decisions to make accurate decisions with a minimum of expense. It is presented as a public service in the interest of sound community development.

A summary of general findings and their implications is presented below. The methodological innovations and mathematical detail of the models is presented in the report itself.

1. Travel has increased 40% since the last comprehensive survey of the metropolitan area was made in 1945. At present, transportation facilities must serve 5,280,000 trips each day in the 100 cities and towns of the Boston area. The average family in the area makes 6.4 trips per day or slightly less than the equivalent of two trips for every man, woman and child in the population.

2. In 1980 there will be 8,200,000 trips made each day, according to the estimates developed from the model. This is an increase of 55%. This

increase is substantially below the increases forecast in recent studies of highway needs in the Boston Metropolitan area, although it is large enough to indicate a need for large expenditures on the expansion of transportation facilities. The principal factors influencing this growth were found to be increasing population and increasing car ownership. Increasing income and leisure time will also be of related influence.

3. While total travel by persons residing in the Boston region will increase by 55% between now and 1980, the number of automobile driver trips is calculated to increase by almost 100%. During the same period the number of passenger trips (passengers, not including drivers, in automobiles, trucks, taxis, and mass transit) is expected to decrease slightly. Thus the total increase in personal trips will take place as automobile trips. The net impact will be twice as many vehicles on the streets, highways, and expressways of Regional Boston in 1980 as there are now.

   This expectation makes obvious the need for more space and improved systems of vehicle maneuverability and parking.

4. In Metropolitan Boston there is now an average of .91 cars for each family (slightly less than a car for each family). This is relatively low compared to many other cities in the United States. By 1980, there is expected to be as many as 1.4 cars per family. There will be 650,000 more cars on the road in this area than there are now. It has also been found that as average per family car ownership increases, the total number of trips made by a family increases. While the number of trips to work remains about the same, trips for shopping, recreation and social purposes all increase.

5. Of particular importance in highway construction is the fact that as car ownership per family increases, the number of persons in the vehicle during each trip tends to decrease. Thus, instead of an average occupancy of 1.45 persons per car on each trip, we can expect only 1.25 persons per car on each trip in 1980. This will magnify the demand for highway facilities.

6. The new traffic problems of the future will be concentrated in communities near and beyond Route #128. In the period from 1975 to 1980 particularly severe problems will occur. Communities in this area will experience average increases in passenger car travel ranging from 140% to 200%. This will mean there will be a need for a continuation of a program of arterial and circumferential highway building, and also for programs to construct many minor facilities to distribute traffic within the localities. This suggests that the facilities constructed under the "Interstate System" of 90% federally aided highways will not be sufficient to meet all the intra area needs of the region. It is important to consider this fact in planning for the future since state and local outlays for secondary facilities will have to be continued and undoubtedly increased.

7. The increased proportion of trips for non-work purposes will mean greater mid-day utilization of the transportation system. In many areas, recreation, social and shopping trip demand will far exceed work-trip demand. Where this occurs the work-trip now occurring in the peak hour

may no longer set the maximum demand for transport facilities. Before this occurs, highway administrators will have to modify or abandon building programs to meet past demands and habits and utilize methods such as those proposed herein in anticipating not only future traffic volumes but also the time and purposes of trips. Otherwise, funds will be spent on facilities that will soon become obsolete.

INTRODUCTION

The subject of urban transportation in the metropolitan areas of this country has received attention from civic and business leaders, government officials and the general public. This wide-spread interest is only natural and justified. Urban transportation is one of the major, if not the most important, threat to the healthy functioning of our cities. It has and will continue to have the greatest influence and implications upon the manners and habits of all urban residents.

The Boston College Seminars are engaged in studies of the issues and problems of the Boston Metropolitan region, such as, finances, government, development, housing, education and many others. They have emphasized from the beginning the singular importance of urban transportation, and its effect upon the stability and prospects of the economy.

Urban transportation has long been a major problem of cities. To provide better and more efficient means of communication and movement has been the goal of officials since the very beginning of cities. The impact of the Industrial Revolution upon American Cities during the 1800's compounded the urban transport problems by creating systems of centralized manufacturing, resulting in a need for large labor pools, and bigger and bigger cities. At the same time, the products of the Industrial Revolution provided the means for moving greater numbers of people to the centers of employment. The internal

combustion engine, electricity and particularly the electric motor, became the tools of the early planners of our modern urban transportation system. The first thirty years of the 1900's can rightly be called the years of mass transportation. The private motor vehicle had made its appearance upon the streets of Downtown Boston to be sure, but the spreading of street car lines into the continually expanding residential areas, the increasing reach of subway and rapid transit lines, and the popularity of the commuter railroad were all factors that allowed and encouraged the creation of the highly developed city center as we know it today. With these high-capacity transportation facilities available, the Central Business District flourished at the intown cross roads of the radial approaches. The Downtown Area was without question the focal point of the majority of business, industrial, social, cultural and recreational activities.

The second thirty years of the 20th century present a strong contrast to the first thirty years. This era has been dominated by the automobile which because of its individuality, mobility and flexibility threatens to undo the cities that the mass transit facilities created. Suddenly, cities are spreading out in a manner completely unforeseen by the specialists of yesterday. The undeveloped land between the corridors of radial transit rail lines is being filled in by homes and industries. The many square miles of hinterland have become one and two acre lots. It has been often said that the center of the city

is to be doomed by the process of decentralization of business from the Downtown Area. Circumferentials, such as Route 128, have become popular in order to gain additional land for new industries that do not want downtown locations partly because of the traffic tangle.

The impact has been great. Nearly every family has a car; many families have two. Fewer and fewer people visit the center of the city. Smaller proportions of metropolitan jobs are located Downtown. The increasing amount of travel in automobiles has long since overcrowded the streets and highways. Municipal, state and the federal Governments have annually invested large sums to aid in the solution of the traffic tangle. Total automotive travel has more than doubled since 1940 increasing from 302 billion miles in that year to 628 billion miles in 1956. Dollars for the construction of highways and roads to accommodate this travel have more than tripled in the same period, increasing from $2.4 billion in 1940 to $7.5 billion in 1956. The attention given to the problems of traffic during the post World War II period has been emphasized by the decision of the Federal Government to provide further financial aid (90% of the costs) for the construction of an Interstate system of limited access expressways between and through our urban area.

Despite this attention, the friction, waste and inconveniences of urban travel remain the principal threats to American cities. The automobile has proved to be the real challenge

to the designers of cities as well as to the builders of transport facilities. The motor vehicle has had its impact upon other means of urban and interurban travel. The railroads, bus companies and rapid transit facilities all have felt the popularity of the car through reduced passenger flows. The future prospects of many of these mass transportation services are poor.

In view of the rapid changes in the technology of transportation and in the structure of cities, fundamental questions concerning the future of urban life have been raised. What will be the outstanding features of the next thirty years? How will the economic and physical structure of our cities change? Will the Central Business District retain or regain its previous dominant position or will the Downtown Area continue to diminish in relative size? Should the central city be saved, and how? Or is the future of American cities to be in the spreading suburbs, or in new satellite cities and towns at the periphery of the metropolis? What means of communication and transportation will be needed to help create and serve the city of the future?

One cannot completely ignore the possibilities of new means of communications and transport. For example, the development of efficient and inexpensive video telephone would substantially reduce the need for travel. Moving belts or new forms of inter-urban air travel could have great influences up-

on the amount, type and location of residential and commercial development.

But new innovations will undoubtably be less influential than current everyday decisions that increase or decrease mass transit or commuter railroad fares; that allow abandonment of a rail line or construction of a new rapid transit extension; that raise, lower or change the fee for off-street parking; or that locate new expressways. Each of these decisions helps create the transportation system of the future; and therefore, the city of the future.

Despite the poor post war trends and gloomy forecasts for mass transportation, many cities are again considering it as a principal solution for automobile congestion in the city center. Most of the 15 largest cities of North America are currently studying, planning, or constructing major mass transit facilities to supplement systems of expressways now under construction. These cities have realized that the automobile and the strong centralized downtown area are fundamentally incompatable. The transportation decisions to be made must weigh the advantage and disadvantage of a strong downtown as against a spreadout pattern of commercial and industrial development. Also to be considered are the costs of alternative types of transportation, the indirect costs of alternative patterns of land use, the desires of the consumer, the requirements of economic development, and many other fundamentals that must be satisfied.

These are complex and interwoven problems not easily solved. But these are the problems that must be solved in the near future if the city, in a meaningful form, is to survive. In order to provide the basis for decision and solution, research is necessary. Out of research can come a system of transportation which will serve all of the needs of the city and the region with a minimum of friction and with the greatest contribution to economic and social prosperity.

URBAN TRANSPORTATION PLANNING AND RESEARCH

Urban transportation planning and research has not reached a level of sophistication commensurate with the importance that transport decisions and construction have upon the health, welfare and future of American Cities. Decisions in urban transportation which will shape the future city are too frequently made on a day to day, crisis to crisis, project to project basis without adequate regard for the many long-range implications. The decisions which commit billions of dollars of highway and transit funds for years to come are often guided by subjective judgement rather than objective analysis of the facts. But the decisions must be made or the city will suffer from traffic strangulation. If time proves that the decisions are wrong, the error cannot easily be placed at the feet of those who were responsible. The error may be due either to the lack of information and understanding of the fundamentals of the problems or ignorance of the available alternatives. The real weakness and cause for error is the lack of adequate transportation planning and research.

Urban transportation planning and research in most American cities is neither complete nor comprehensive. It lacks consistency, depth, and sensitivity. A typical metropolitan transportation crisis; the abandonment of a commuter railroad line, a need for a new highway or parking garage, or a fare increase by the local transit line usually causes a rash of new studies

and the collection of new data. These studies are expensive, often useless. They are fragmentary in that they consider only one aspect of the problem and often offer solutions that generate new problems in other areas. The results of the special studies become suspect and the period of decision becomes prolonged at the expense of the regional economy.

The inadequacies of current transportation planning and research can be explained but not justified. The general failure of urban transportation engineering to lead the course of events rather than follow, is primarily caused by the many changes that have occurred in the travel behavior of urban residents during the past two decades. Research, planning, and traffic engineering have not kept abreast of changes that have resulted from the acceptance and use of the automobile. The acceleration of urban highway construction programs and the continual rise of crises have given the urban transportation specialist little time to develop the necessary foundation of information upon which decisions should logically be based. More often than not the demand for fast action has resulted in the postponement of the opportunity to undertake comprehensive urban transportation research.

Beginning in the late 1930's and carrying into the 1940's and 1950's, the Bureau of Public Roads of the U. S. Department of Commerce encouraged the collection of more meaningful data to justify the expenditure of Federal funds for urban highways.

The method of data collection took the form of Origin and Destination Surveys wherein a probability sample of 2% to 5% of the total families in a metropolitan region were interviewed about the nature of their daily travel. The results were easily expanded to reflect the location and orientation of 100% of all trips in the region. Origin and Destination surveys are still the primary means for collecting data concerning urban travel characteristics, and remain as the best source of information required for analysis and understanding of many of the complexities of urban movement.

Most large American cities have had origin and destination surveys. Unfortunately, some areas were surveyed shortly after World War II and these studies do not accurately describe the true impact of the automobile in the post-war era. The Boston Area underwent an origin and destination survey during the Fall of 1945, only one or two months after the ending of gas rationing. The resultant data is now considered to have very limited usefulness because it was greatly influenced by war-time conditions and because it is 14 years old.

Even up to date origin and destination surveys have limited usefulness . They have four failings. First, such surveys, because of the large sample involved, have collected so much data as to make appropriate analysis and investigation of alternative solutions a difficult task. This problem has been reduced through use of data processing equipment.

Second, origin and destination surveys were often used only to determine the existing geographic patterns of urban travel, but too little effort or money was spent for investigation of more fundamental travel relationships that help describe why travel patterns existed as they did. Many times the results of the comprehensive home surveys were never fully analyzed to obtain a deeper insight into the causes of travel or the means for estimating future travel more accurately.

Third, origin and destination surveys have not been kept up to date so as to continually incorporate changes in travel patterns caused by additional population, decentralization of homes and industries, and the impact of the automobile upon the amount of travel.

Fourth, origin and destination surveys which necessitate interviews of large percentages of the households of a region are costly in terms of money and human resources.

All of these failings can be corrected through modification or replacement of parts of the origin and destination process.

THE BOSTON COLLEGE STUDIES OF URBAN TRANSPORTATION

The Boston College Studies of Urban Transportation have been designed to fill some of the gaps that exist in the field of urban transportation research and to develop new tools of analysis leading to better understanding and knowledge of the complex subject of urban mobility. The Seminar Research Bureau believes that the problems of urban transportation can be solved more easily and logically, and with better insight of long range requirements, when the methods and usefullness of transportation planning and research are improved. Specifically, the objectives of these Studies of Urban Transportation are to:

1. Formulate a process of urban travel analysis that

    a. corrects the failures of existing methods of research by making use of techniques available from other disciplines and by utilizing new estimating procedures made possible by modern computers.

    b. is relatively inexpensive -- often as little as 10% of the costs of a normal Origin and Destination Survey.

    c. can easily be kept up to date by annually incorporating easily obtainable data reflecting changes in population, economic activity and basic travel habits.

    d. is accurate enough to guide urban transportation and development policy decisions.

    e. represents a more sensitive reflection of constantly changing socio-economic and travel conditions.

f. provides a more accurate method of estimating future travel potentials.

2. Utilize the methods developed for analysis of existing and future travel in Metropolitan Boston for evaluating the highway and transit needs and proposals of the Boston area.

There are three related phases of the Boston College Study. The first Phase is the subject of this report; Phases two and three will be reported upon in the near future.

Phase I is the development of information describing the amount and general characteristics of daily travel made by residents of the 100 cities and towns, or traffic zones, of the Boston Region for 1959 and 1980.

Phase II is the development and utilization of a process to distribute the daily travel among the 100 cities and towns. This phase of the study involves the construction of the pattern of origins and destinations throughout the region for both existing and future conditions, without undertaking a costly 2, 3 or 5 percent sample survey. The process to be used is the application of an "Inter Area Travel Formula" or "Gravity Model". These are terms for a mathematical expression containing factors which account for the attracting forces that generate travel, and the frictional forces that limit the length of the trip. This mathematical expression has been developed from the analysis of travel habits and origin and destination surveys in cities throughout the country. Considerable experimentation is required before this approach of artificial construction of

origins and destinations is completely acceptable. The research and experimentation contributed by these studies is expected to further refine the technique and expand its potential usefulness.

The general form of the mathematical equation is:

$$T_{1-2} = (T_1) \frac{\frac{M_2}{X D_{1-2}}}{\frac{M_2}{X D_{1-2}} + \frac{M_3}{X D_{1-3}} \cdots \frac{M_n}{X D_{1-n}}}$$

where: T_{1-2} is the number of trips that occur daily from zones 1 to 2.

T_1 is the number of trips that begin daily in zone 1.

M_2 is the size of zone 2.

D_{1-2} is the distance between zones 1 and 2

Phase III of these studies is the comparison of existing and future origin and destination patterns in Metropolitan Boston with the capacities of streets, highways, expressways and transit lines; and an evaluation of facilities proposed for the region.

The accuracy of the results of the three phases cannot be accurately estimated until the final values have been formu-

lated and analyzed. The results are expected to be accurate enough to provide Metropolitan Boston with a foundation of knowledge capable of allowing objective, logical transportation decisions. It is visualized that the data will be adequate to evaluate proposals for the number, general location and capacity of systems of highways, transit and parking in Regional Boston. It is not expected, nor intended, that the results of these studies are to be used as primary determinants for detailed transport facility design; or for detailed locations, capacity or design of minor components of the proposed transportation network. Other factors such as costs, land development programs, physical features of the terrain and local transport conditions rightly play an increasing role in such decisions.

Traffic data, regardless of how it is collected, processed and projected can be no more accurate than the accuracy of the estimates of underlying determinants such as population projections. Therefore, it is folly to process and present traffic data that is supposed to be completely accurate in all respects. Instead, the attempt has been made to develop travel information data that maintains a consistent level of accuracy. By doing this and by recognizing that errors of estimate of future population, car ownership and future travel are bound to exist; and by indicating what these levels of accuracy are, the range of alternative future conditions can be understood more readily.

TRAVEL CHARACTERISTICS IN METROPOLITAN BOSTON

Changing urban development patterns, new and better highways, and higher car ownership ratios have caused the amount of daily travel by urban residents to increase. Studies in other cities have shown that the average urban family with one car will make between 6 and 6.5 trips per day. The actual number depends upon many local conditions. These studies also show that within a metropolitan area there is a great range in the number of trips per family. This number seems to be related to the socio-economic and living characteristics of the individual family.

The objective of Phase I is to learn how many trips are produced within Metropolitan Boston for various purposes and by various modes of travel. In order to carry out Phases II and III, it is necessary to establish the amount, purpose, and mode of daily travel in each city and town of the Boston region; the relationships between daily travel characteristics and socio-economic characteristics of families in the Boston region; and estimates of future travel characteristics likely to occur because of changing socio-economic levels.

PROCEDURE

To obtain the data required, the Seminar Research Bureau conducted a limited home interview survey of residents of Metropolitan Boston. The results of this survey have been carefully analyzed for correlations between travel and socio-

economic characteristics and the results of these correlations have been expanded and projected to establish trip production by purposes and mode of travel for each city and town, or traffic zone, for 1959 and for 1980.

Sample Survey - The survey took place during the Fall of 1958. The survey was carefully designed to involve a minimum sample size and to obtain an error of estimate of total trip production of within plus or minus 10%. One hundred families were randomly selected in each of 10 communities which were also selected at random from among the 100 cities and towns of the region. A total sample of 1000 families selected from the 825,000 families in the region is a sample of only .12 percent. This small sample was made possible by a number of special conditions. Most important is the fact that this survey does not seek to obtain a description of origins and destinations but only values of trip production and their variations because of related socio-economic factors. Other surveys throughout the country have provided data describing the magnitude and statistical deviation of trip production from mean values. Therefore, statistically it was possible to determine that a sample of this size would provide the desired data within a selected margin of error of plus or minus 10%.

Each family was asked about its family characteristics and travel undertaken the previous day. The questions dealing with travel were essentially those asked in a normal origin

and destination study as approved by the United States Bureau of Public Roads. (See Appendix I for a copy of the interview forms.) The information sought included a full description of all the trips made by all members of the household including the purpose of the trip, origin and destination, time of day, time length of the trip, and the mode of travel.

The actual interviewing took place simultaneously in all 10 communities during the last two weeks of October, 1958, the entire month of November and the first two weeks of December, 1958. Approximately an equal number of interviews was obtained for each of the five working days of the week, Monday through Friday, by interviewing on Tuesday through Saturday. The survey did not seek information regarding travel on weekends.

The interviewing was conducted by senior students majoring in the Marketing course of the College of Business Administration at Boston College. The majority of the interviews took place after school hours in the late afternoon and early evening when most members of the interviewed family were at home. This timing caused the resultant interviews to be more complete and accurate since the required information was obtained directly from the person who had made the trip.

Each family to be interviewed received a letter requesting cooperation, a brief description of the intent of the survey, and a simplified version of the interview forms.

The ten communities (or traffic zones) included in the

sample survey were Beverly, the eastern half of Cambridge, Malden, Stoneham, the Fens area of Boston, Needham-Dover, Hyde Park, Dedham, North Dorchester and Quincy.

The results of this survey have been processed on IBM cards and fully analyzed for correlations between the amount and type of travel, and such soci-economic factors as family size, type of housing, number of cars and distance from Downtown Boston. The most useful correlations were used to determine the amount and type of travel produced in cities and towns not surveyed. The correlations have also been used to estimate future travel characteristics in cities and towns in 1980.

FINDINGS

The Boston College limited sample survey of travel habits of residents in Metropolitan Boston proved successful in providing the information required. The results and findings are reported on in four parts: I. a summary of total metropolitan travel for 1959; II. a description of the useful correlations between travel and socio-economic characteristics of the residents of the Boston Region; III. a description of travel production in each of the cities and towns, or traffic zones; and IV. a description of metropolitan wide, and city and town travel estimates for 1980.

Findings I - Metropolitan Travel for 1959

Statistical expansion of the survey results show that some 5,280,000 trips take place on an average day by the residents of the Boston Metropolitan Area. These trips are for all purposes and by all modes of transport excluding only walking and cycle trips and those trips by truck, taxi and mass transit drivers. This gives an average of 6.4 trips for each family in the region and 1.75 trips for each person. A. 1959 average of 1.75 trips per person compares with an average of 1.26 trips per person counted by the Boston Metropolitan Origin and Destination Survey of 1945. During the 14-year period between surveys the average person increased his amount of travel by the equivalent of one-half a trip per day. This is primarily caused by the increase in car ownership on a per family and per person basis, as well as the post-war improvements

A significant fact is that these values differ little from purposes of trips in other major cities in the United States. It is quite likely that some of the minor differences that do occur are caused by difficulties in consistent definitions and interpretations of various travel purposes.

The purpose distribution of those trips not beginning or ending at the home (non-home based trips) differ from those originating or destined for the home as would be expected.

Metropolitan Boston - Purpose Distribution of Non-Home Based Trips

	Percent of total
1. work	16.3
2. Business related to work	20.1
3. shopping for shopping goods	11.6
4. shopping for convenience goods	4.9
5. personal business	9.1
6. recreation	9.7
7. social	13.1
8. education, civic or religious	4.9
9. serve passenger	10.3
	100.0

The trip purposes listed above have been regrouped into the five more general trip purpose classifications that will be used in later phases of the study. The categories are 1. work; 2. for social, education, civic religious and serve passenger; 3. for shopping of both shopping and convenience goods; 4. for personal business, recreation and business related to work and 5. to home. Trip purposes 2, 3 and 4 have also been grouped into a summary category entitled "Non-Work Trips."

Work Trips

There are 865,000 daily trips to work in Metropolitan Boston, or an average of 1.049 trips per family. Work trips account for the greatest number of trips that begin at the home daily, and account for about 20% of all daily trips. These work trips consist of all trips to work including those that return to work following a non-work trip (for example, a trip to lunch or for shopping) during the work day. Primary work trips, the initial daily trips to work, account for 90% of the total number of worktrips. The computed statistical accuracy of these metropolitan-wide values show the figures to be correct within plus or minus 1.53% with a 95% confidence level.

Non-Work Trips

Non-work trips for shopping, personal business, social trips, etc. total about 1,300,000 trips per day for the entire region or an average of 1.572 trips per family. These values have an accuracy of plus or minus 1.64% with a 95% confidence limit.

Social, Education, Civic, Religious and Serve Passenger

Trips for these purposes occur about 710,000 times during the average day, or an average of .858 trips per family. The accuracy of the figures is plus or minus 1.98%, 95 out of 100 times. This category accounts for about 55% of all of the non-work trips that occur daily.

Shopping Trips

Travel for shopping purposes for both convenience and shopping goods occurs about 310,000 times per day for an average of .377 trips per family. The accuracy of these estimates is plus or minus 2.39%; a somewhat larger margin of error than computed for other types of trips because of the considerable variation of the number of shopping trips taking place during different days of the week.

Personal Business, Recreation and Business Related to Work Trips

Approximately 280,000 trips for these purposes are made daily by residents of the region, an average of .337 per family. The accuracy of this estimate is plus or minus 3.26%. This type of trip also has a larger variation from day to day and family to family and therefore, a greater margin of error of estimate.

Mode of Travel

The travel habits of residents of the region have also been analyzed in terms of the method of travel utilized. The classifications are automobile driver, motor vehicle passenger (excluding truck driver and taxi driver trips) and transit passenger.

The greatest amount of daily travel in Metropolitan Boston is made by automobile drivers. They account for approximately 2,380,000 or 55% of the 4,300,000 total homebased trips. This is an average of 2.879 automobile driver trips per family per day.

Motor vehicle passenger travel is the second largest selected method of travel resulting in 1,060,000 homebased trips per day or 1.282 motor vehicle passenger trips per family. The remaining mode of transport, mass transit on buses, trains, and rapid transit lines, accounts for about 870,000 trips per day throughout the Metropolitan Region, or 1.053 daily trips per family.

The methods of selected travel in 1959 show substantial differences when compared to the results of the 1945 Origin and Destination Survey as reported in the Master Highway Plan of 1948.

The total number of person trips in passenger cars and taxi made by the 1,810,000 residents of the area studied in 1945 was about 1,150,000 or .63 trips per person. This compares with the present value of about 1.15 trips per person. Thus, the amount of travel by people in passenger cars now is almost twice as much as in 1945. On the same basis passenger car and taxi vehicle trips averaged .35 per person in 1945 compared with the present average of .80 per person. Thus the number of vehicle trips per person has more than doubled since 1945.

The fact that the number of passenger vehicle trips in Metropolitan Boston has more than doubled is the fundamental explanation of the region's traffic and transportation problems and shows the need for more and better transport facilities. The additional travel contributed by continually expanding population in the suburban communities also adds its influence to these costly problems.

During the same 1945 - 1959 period the number of transit passengers in Metropolitan Boston decreased from 979,471 trips in 1945 (according to 1945 O & D Survey) to 870,000 in

1959. For comparable areas (excluding the growing suburbs that are beyond the areas of intense mass transportation and were not included in the 1945 survey) the number of mass transportation passengers has decreased from .55 trips per person in 1945 to about .40 trips per person in 1959.

The table on the next page summarizes the results of the sample survey when expanded to account for total Metropolitan travel. The results are shown in terms of average trips per family and total travel for each of the purpose and mode classifications indicated.

Time Characteristics of Boston Metropolitan Travel

The time of day during which trips are undertaken is an important characteristic of metropolitan travel since the proportion of travel occurring during the peak hours of morning and evening is often used as a basic guide for measuring the adequacy of transportation facilities.

The survey showed that while 14.5% of all person trips started during the peak hour of the morning, (7:20 to 8:20) the amount of travel during this a.m. peak hour by different modes of travel varied considerably. About 11.8% of all auto driver trips and 14.5% of the motor vehicle passanger trips were made during the a.m. peak hour. However, some 22% of all transit-rider trips were made during the same peak-hour period. Similar values would apply to the afternoon peak hour which occurred from 4:30 p.m., to 5:30 p.m. The public service function of mass transportation and a basic problem of the mass transportation industry is highlighted by the amount of peak-hour use. Although transit serves only about 20% of all metropolitan travel throughout the entire day, it serves some 33% of all travel occurring during the peak hour.

Another point of interest is the difference in automobile occupancy during the peak hour compared with other hours of the day. The average automobile occupancy for all trips throughout the entire day is 1.45 persons per car. During the a.m. peak hour the equivalent ratio is 1.55 persons per car.

One of the more important features of metropolitan travel is the pattern of length of trips. Measured in terms of time rather than distance the length of trips varies considerably according to the purpose and mode of travel.

Chart #A shows the pattern of all non-work trips compared to all work trips. The chart shows the cumulative percentage of trips for both purposes that are of various lengths.

Table # 1

Seminar Research Bureau
Boston College

Metropolitan Boston Travel Characteristics 1958 - 1959

Metropolitan Survey Results and Statistical Reliability for Entire 100 Cities and Towns

CHARACTERISTIC	AVERAGE VALUE (PER FAMILY)	RANGE OF ESTIMATE	PERCENT RELATIVE VARIATION	RANGE OF TRIPS
Total Trips	6.403	6.233 - 6.573		5,146,214 - 5,426,931
Nonhome Based	1.189	1.105 - 1.273	7.06	912,332 - 1,051,039
Home Based	5.214	5.128 - 5.300	1.65	4,233,882 - 4,375,892
(Purpose)				
To Home	2.593	2.533 - 2.653	2.33	2,091,346 - 2,190,423
To Work	1.049	1.033 - 1.065	1.53	852,886 - 879,307
To Nonwork	1.572	1.562 - 1.582	.64	1,289,650 - 1,306,162
Shopping* 1	0.377	0.368 - 0.386	2.39	303,836 - 318,697
Personal Business*2	0.337	0.326 - 0.348	3.26	269,158 - 287,323
Social* 3	0.858	0.841 - 0.875	1.98	694,363 - 722,435
(Mode)				
Auto Driver	2.879	2.806 - 2.952	2.54	2,316,746 - 2,437,289
Non Driver	2.335	2.292 - 2.378	1.84	1,892,367 - 1,963,372
Vehicle Passenger**4	1.282	1.253 - 1.311	2.26	1,034,527 - 1,082,414
Transit Passenger**5	1.053	1.009 - 1.097	4.18	833,071 - 905,727

1 * Shopping includes shopping for convenience and shopping goods.
2 * Personal Business also includes trips for business related to work, and recreation.
3 * Social also includes trips for education, civic, religious, and serve passenger.
4 **Vehicle Passenger includes passengers in cars, taxis and trucks.
5 **Transit Passengers includes passengers in trains, bus, street cars and rapid transit.

For example 80% of all non-work trips are 20 minutes in length or less while only 50% of all work trips are 20 minutes or less. Similarly over 90% of all non-work trips are 30 minutes or less in length while only 70% of all work trips are 30 minutes or less in length. The two curves indicate that average daily non-work trips are much shorter than daily trips to work. Calculations of the mean travel times for various types of trips show that the average work trip consumed 28.0 minutes while the average non-work trip consumed only 16 minutes.*

Average travel for each of the non-work catagories consumed: for shopping, 14.5 minutes; for personal business trips, 17.8 minutes and for social trips, 15.2 minutes. The average time consumed for all types of home-based trips combined was 23. minutes.

Chart # B compares the length of trips made by automobile with those made as passengers in automobiles and transit. The chart shows that automobile driver trips are shorter than transit trips when measured in minutes of travel.

These patterns are to be utilized in distributing the travel from one zone to another in Phase II.

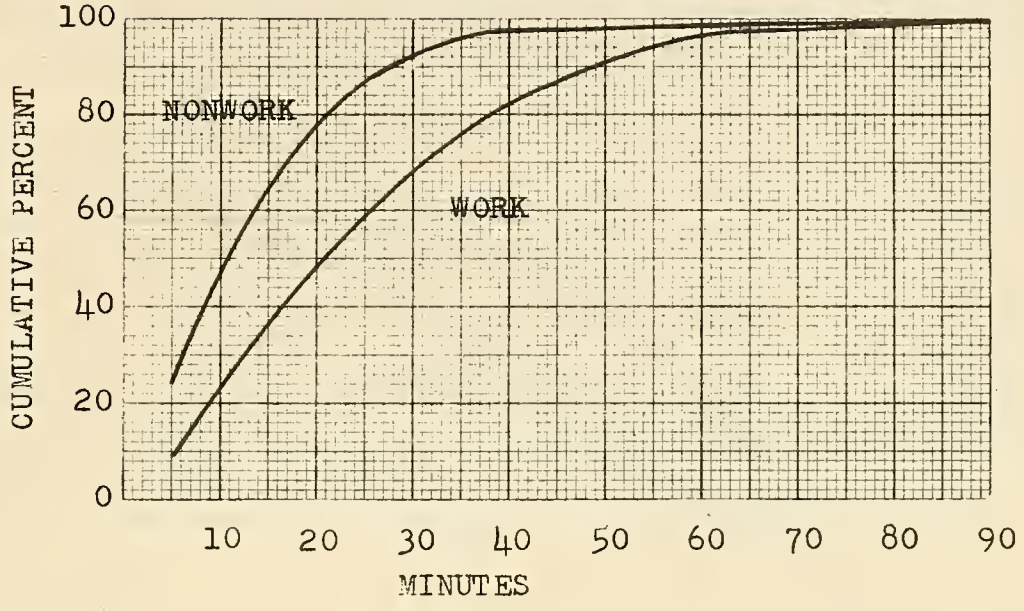
*These travel times are the minutes consumed in actual travel in the vehicle and do not reflect the total door to door time.

STUDIES OF URBAN TRANSPORTATION

Chart # A

Seminar Research Bureau
Boston College

Cumulative Percentage Distribution of Work & Non-Work Trips
Metropolitan Boston, 1959

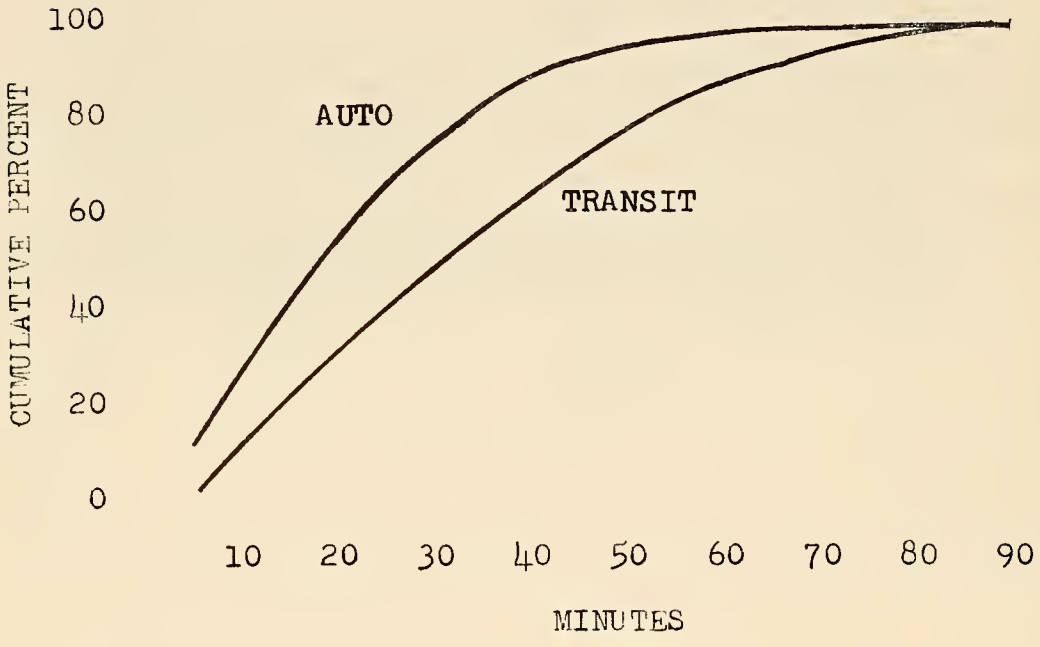


STUDIES OF URBAN TRANSPORTATION

Chart # B

Seminar Research Bureau
Boston College

Cumulative Percentage Distribution of Auto & Transit Trips
Metropolitan Boston, 1959



Findings II - Travel, Social Economic Relationship, Boston Metropolitan Area, 1959.

The frequency and characteristcs of travel by residents of Metropolitan Boston proved to be usefully related to the socio - economic factors of car ownership and persons per family. Analysis of the results of the sample survey shows that the number of trips per family increases as the number of cars per family and persons per family increases. Other socio-economic factors are also closely related to the amount of travel. Such conditions as personal or family income, the type of housing, the distance from the central city and the availability of mass transportation have all been identified as having a high correlation with the average amount of daily travel. Preliminary investigations of the relationships between some of those factors and travel, however, did not show better correlations than car ownership and persons per family and further investigation was not justified.

The best relationships are described below. In all cases the equation of the regression line has been used to determine the amount and type of travel in cities and towns, or traffic zones, throughout Metropolitan Boston. The number of people and cars existing in each city and town of the Region in 1959 is shown in Appendix II.

The equations are most accurate for predicting those types of trips that vary the least from day to day. Total home-based trips, total work trips, and total non-work trips can be

predicted for any city or town with the expectation of being accurate to within plus or minus 8.6%, 8.1% and 4.3% respectively 67% of the time. The statistical analysis shows not as good results for those types of trips that occur less frequently.

It is to be noted that the estimating ability of the predicting equations is much more accurate when applied to the metropolitan area as a whole than when applied to each city or town. This is caused by two factors. First, the combined sample of 100 interviews in each of 10 communities provided a sample of 1000 interviews for the metropolitan area as a whole. This larger sample provided a more accurate measure of daily travel habit variation. Secondly, the relative variation of travel throughout the entire metropolitan area is less than that which occurs in each city or town because of the greater frequency of travel; i.e. the pattern of travel is more stabilized. The accuracy of the predictions for the entire metropolitan area is statistically very good, and in fact may reflect a daily variation of greater accuracy than actually exists because of weather, special events and other travel causing or travel reducing factors.

The statistical accuracies of the estimates for each city and town of the Boston Region are undoubtedly more in line with the actual variations that occur from day to day and month to month. The survey was designed to allow estimates on a town basis with accuracies approximating those that resulted because

it is felt that these accuracies are more consistent with the variation of travel that actually occurs. A greater accuracy is unnecessary, undesirable, and misleading.

A. Total Home-Based Trips Per Family 1958 - 1959

The amount of home-based trips generated per family has been correlated with two independent variables (cars per family and persons per family) and a multiple correlation combining these two variables. The correlation with cars per family has a coefficient of correlation of .851 and a relative variation of 13.8%. The predicting equation is $Y = 1.956 + 3.584 X$ where Y represents the total number of home-based trips and X is the average car ownership ratio for the traffic zone or town. The correlation between total home-based trips per family and persons per family results in a coefficient of correlation of .832 and a relative variation of 14.6%.

Better results occur from a multiple correlation between trips, and persons per family and cars per family. This relationship has a coefficient of correlation of .944 and a relative variation of 8.6%. (Thus the number of trips produced in any zone can be estimated to an accuracy of within plus or minus 8.6% with an expectation of being correct 2/3 of the time.) The predicting equation is $Y = 1.137 + 2.336 X_1 + 1.322 X_2$, where Y is the total number of home-based trips per family X_1 is the car ownership ratio, X_2 is the average number of persons (over 5) per family.

The predicting equation incorporating both independent variables, persons per family and cars per family, has been used to determine the number of trips produced by each city and town in the Boston Region.

B. Work Trips

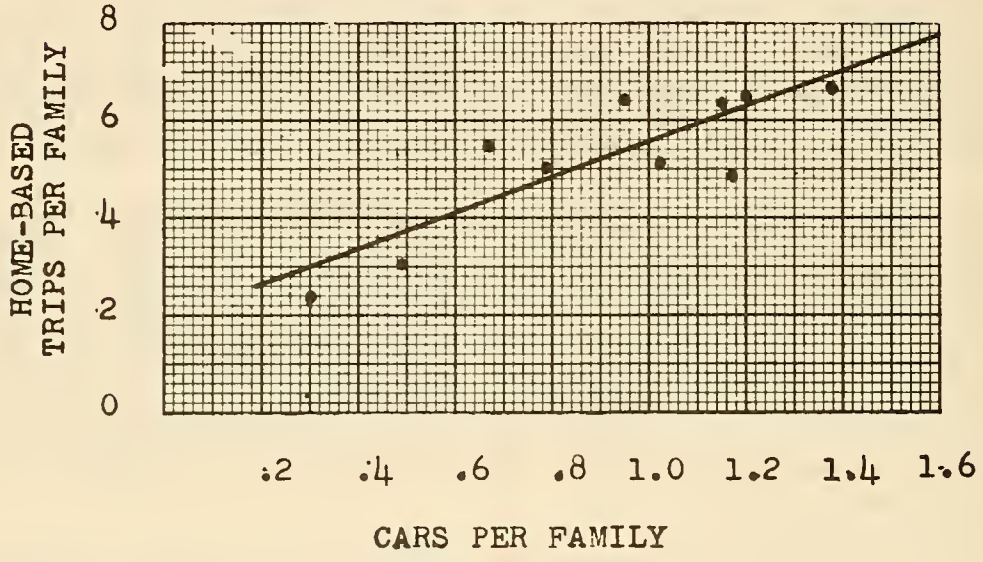
The number of daily to work trips per family throughout Metropolitan Boston shows a strong and useable correlation with the average number of persons per family. The coefficient of correlation between works trips and persons per family proved to be very good, (.941). The relative variation is 8.1% and the predicting equation is $Y = - .389 + .449 X$ where Y equals the average number of work trips per family

STUDIES OF URBAN TRANSPORTATION

Chart # C

Seminar Research Bureau
Boston College

Daily Average of Home-Based Trips per Family
Metropolitan Boston, 1958 - 1959



and X is the average number of persons per family in the town or traffic zone. The regression line is shown on the next page. The number of work trips occuring daily in all traffic zones has been estimated by using the above equation and the results are shown on page 34 .

C. Non-Work Trips

All trips made for other than to work and to home show the most useable correlation and error of estimate. The coefficient of correlation is .908 and the relative variation is 4.3%. The predicting equation is $Y = .268 + 1.434 X$ where Y is the average number of daily nonwork trips per family and X is the average number of cars per family. The regression line is shown on page 35 .

Despite the good predicting accuracy of all non-work trips as a total for each traffic zone, an estimate of the number of trips occuring daily per average family for each specific non-work purpose cannot be accomplished with as good results. Trips for specific purposes other than work are not carried out on a regular basis. The number and pattern of such trips varies greatly from day to day and week to week and this variation causes less accurate estimates of travel.

The trips made for non-work, non-home purposes have been grouped into the catagories previously mentioned: a) Shopping, b) Personal Business, Business Related to Work, and Recreation, and c) Social, Education, Civic, Religious and Serve Passenger. Even when so grouped the correlation and their predicting abilities are not so good as in the case of total trips.

D. Shopping Trips

The correlation between the number of all types of shopping trips per family and car ownership ratios in the towns surveyed is .868 and has a relative variation of 17.8%. The prediction equation is $Y = .050 + .360 X$ where Y equals the average number of daily shopping trips per family and X equals the number of cars per family. The regression line is shown below and the results of the application of this equation are shown in the following section.

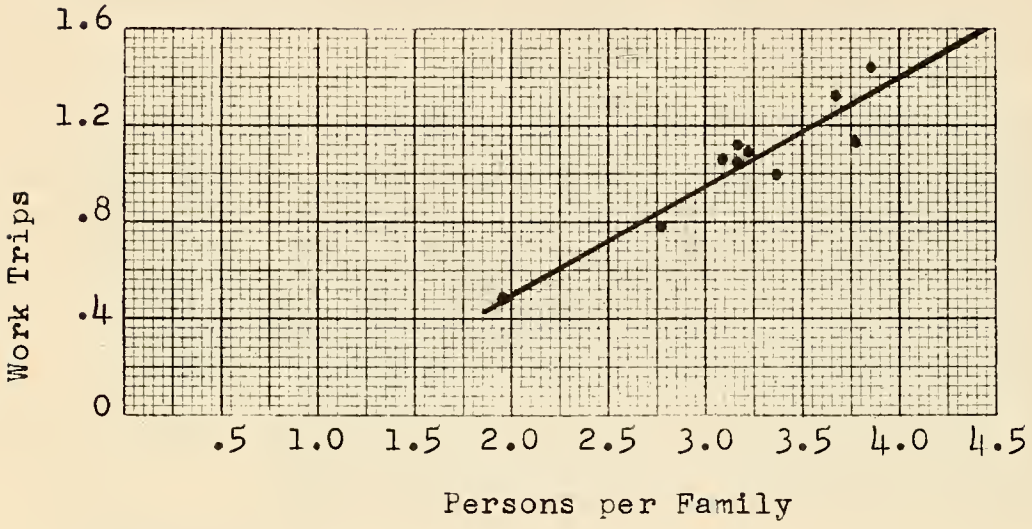
E. Personal Business, Business Related to Work and Recreation Trips

These types of trips are the most poorly correlated with socio-economic factors. The best correlation is found with the average values of car ownership, but the coefficient

Chart # D

Seminar Research Bureau
Boston College

Daily Average of Work Trips per Family
Metropolitan Boston, 1959

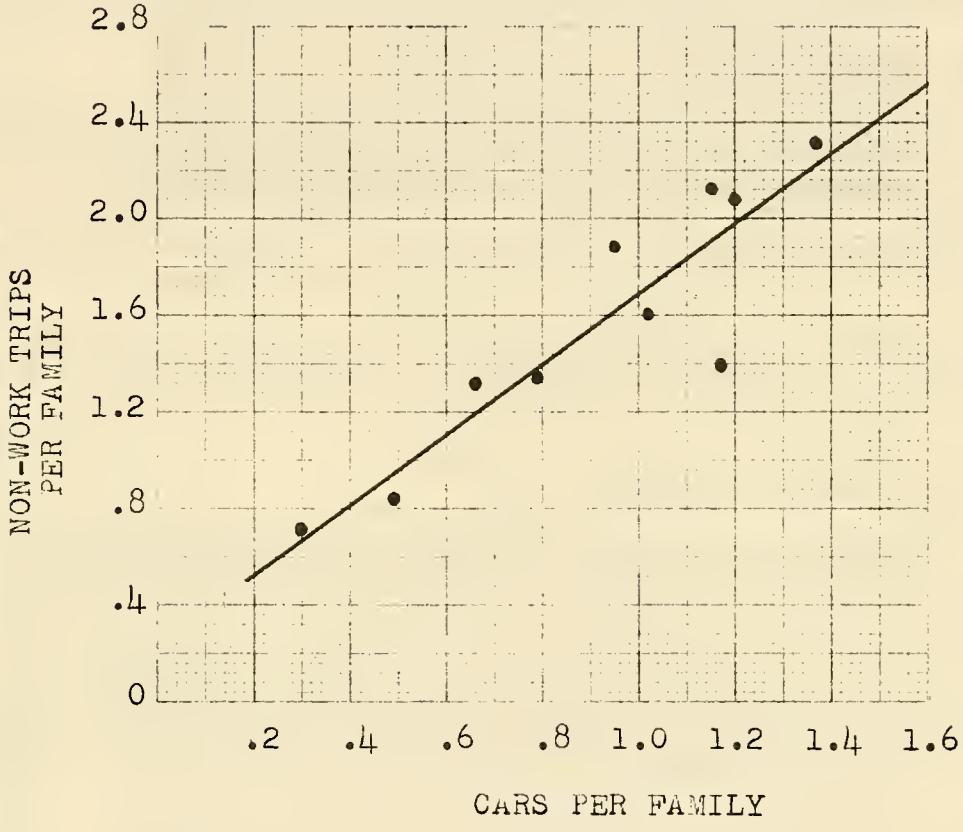


STUDIES OF URBAN TRANSPORTATION

Chart # E

Seminar Research Bureau
Boston College

Daily Average of Non-Work Trips per Family
Metropolitan Boston, 1958 - 1959



of correlation proved to be only .761 and the accuracy of prediction only 33.2%. The predicting equation is $Y = -.030 + .404 X$ where Y is the average number of such trips per family and X represents the car ownership ratio. The regression line is shown on the opposite page.

F. Social, Civic, Education & Religious and Serve Passenger Trips

Correlations between these trips and car ownership showed a coefficient of correlation of .819 and a relative variation of 17.7%. The predicting equation is $Y = .251 + .667 X$ where X equals the average number of cars owned per family. The regression line is shown on page 38.

G. Auto Driver Trips

Correlations between automobile driver trips and car ownership showed a coefficient of correlation of .980 and a relative variation of 8%. The predicting equation is $Y = -.300 + 3.498 X$, where Y is the average number of auto driver trips per day per community and X is the average car ownership. The regression line is shown on page 39.

Further correlations between the average number of cars owned per family and automobile passenger trips and transit trips were less satisfactory.

H. Motor Vehicle Passenger Trips

The number of motor vehicle passenger trips when related to the number of cars per family in each of the 10 communities surveyed showed a coefficient of correlation of .742 and a relative variation of 24.2% expected two out of three times. The regression line is shown below and the equation is $Y = .302 + 1.078 X$ where Y is the number of motor vehicle passenger trips per family and X is the average number of cars per family.

I. Transit Trips

The best predicting relationship for estimating the number of transit trips expected to take place in each city and town of the region proved to be between transit trips per person and cars per person. The regression line is shown on page 40 . The equation for the regression line is $Y = .833 - 1.792 X$ where Y equals the average number of zonal transit trips per person and X is the average number of cars per person. The coefficient of correlation is $-.812$ and the relative variation is 33.8%. This relationship is the weakest of the group of socio-economic and travel relationship because of the great amount of variation in

Chart # F

Seminar Research Bureau
Boston College

Daily Average of Shopping Trips per Family
Metropolitan Boston, 1958 - 1959

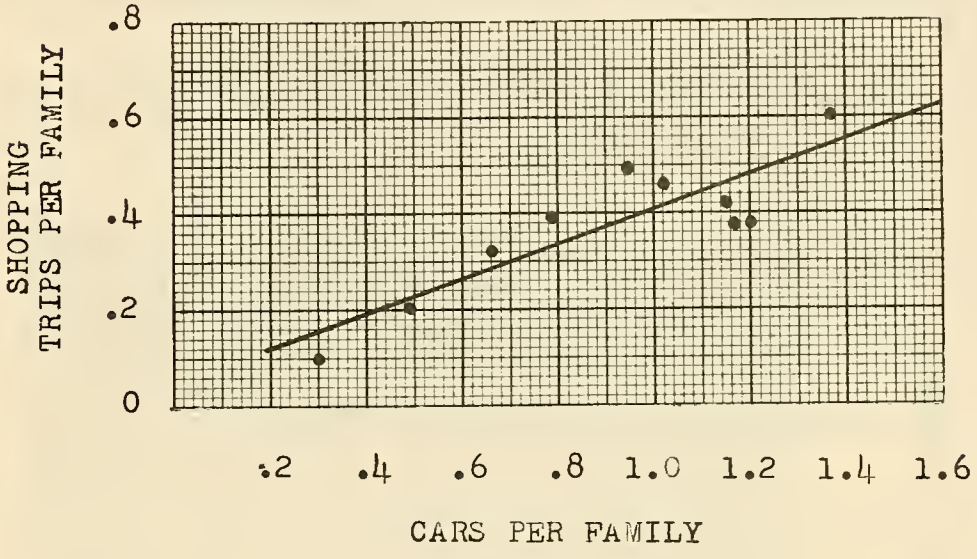


Chart # G

Daily Average of Personal Business Trips per
Family, Metropolitan Boston, 1958 - 1959

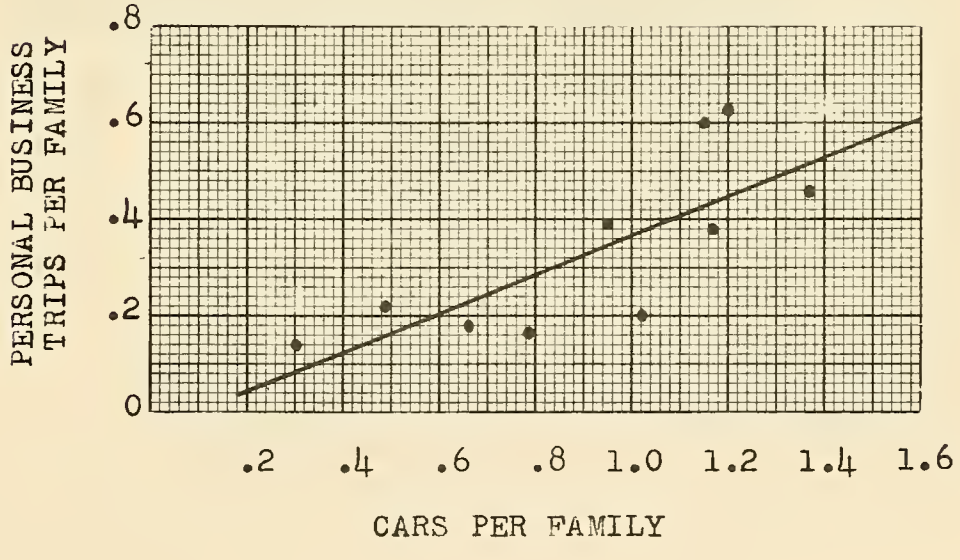


Chart # H

Seminar Research Bureau
Boston College

Daily Average of Social Trips per Family
Metropolitan Boston, 1958 - 1959

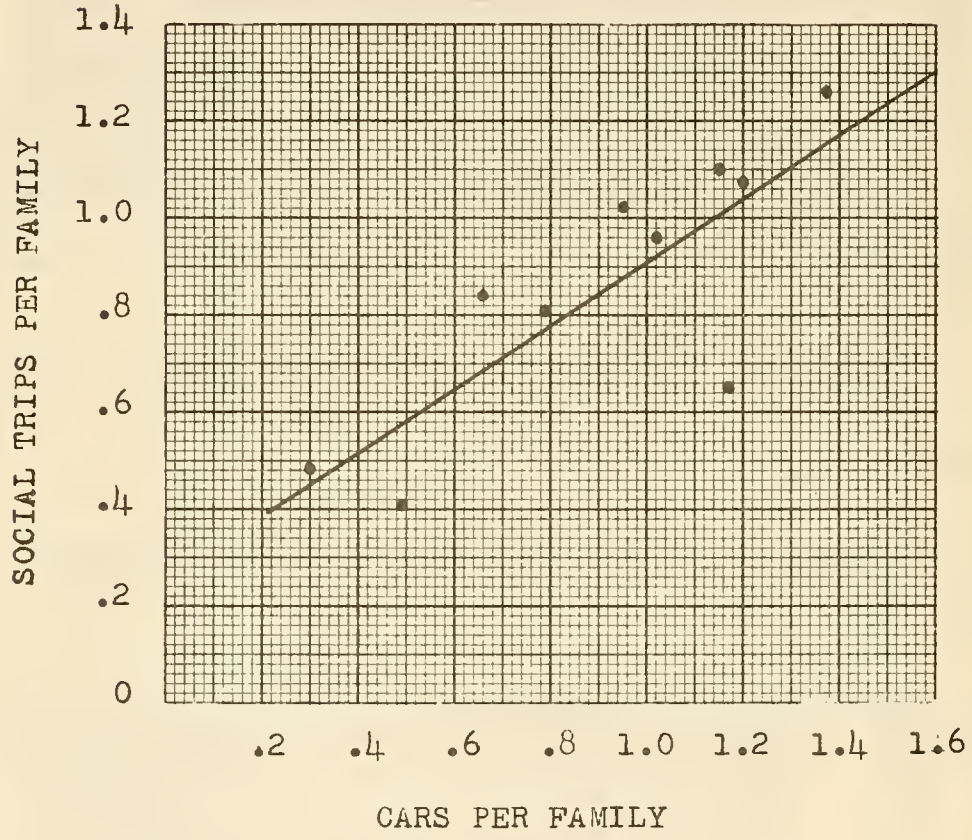


Chart # I

Seminar Research Bureau
Boston College

Daily Average of Auto Driver Trips per Family
Metropolitan Boston, 1958 - 1959

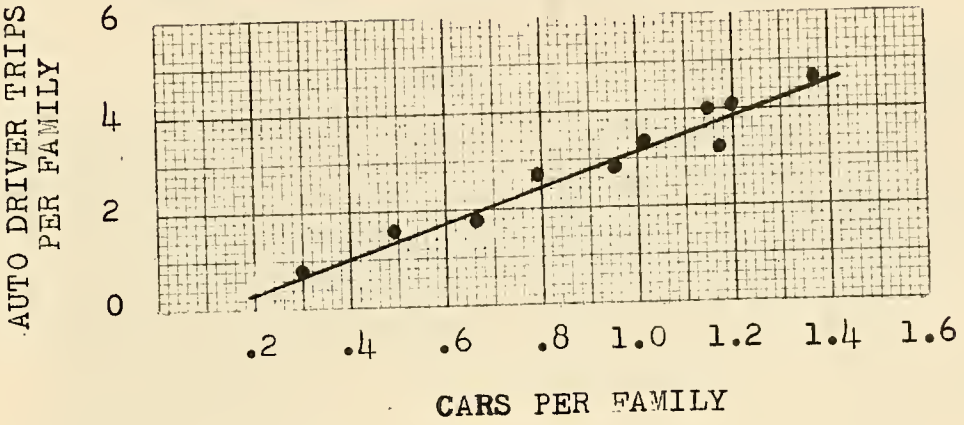


Chart # J

Daily Average of Passenger Trips per Family
Metropolitan Boston, 1958 - 1959

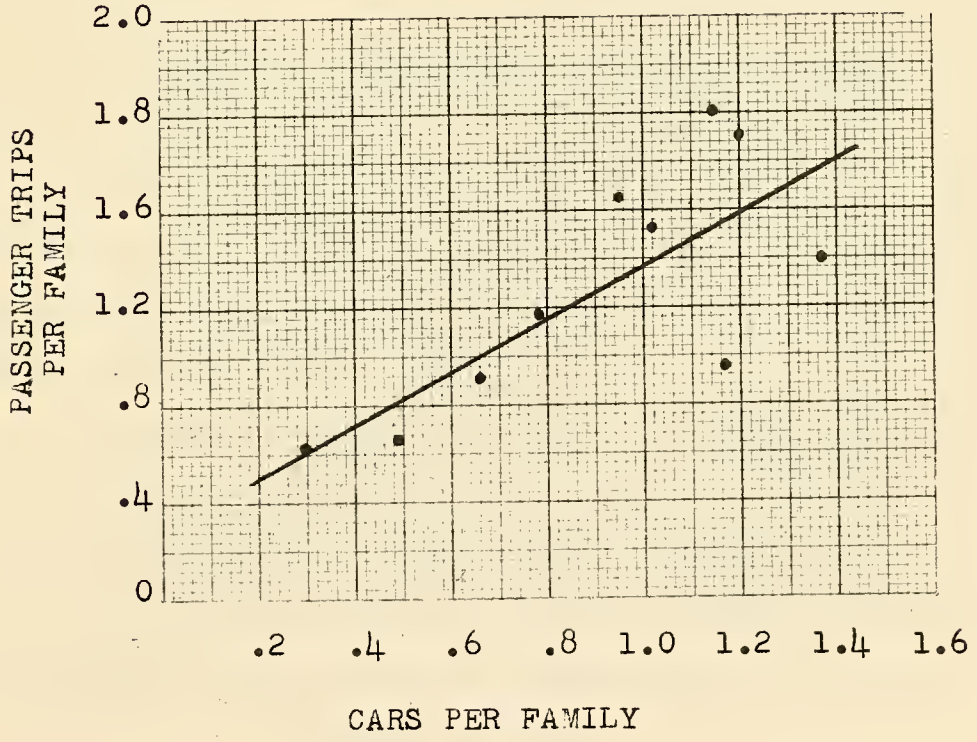


Chart # K

Seminar Research Bureau
Boston College

Daily Average of Transit Trips per Person
Metropolitan Boston, 1958 - 1959

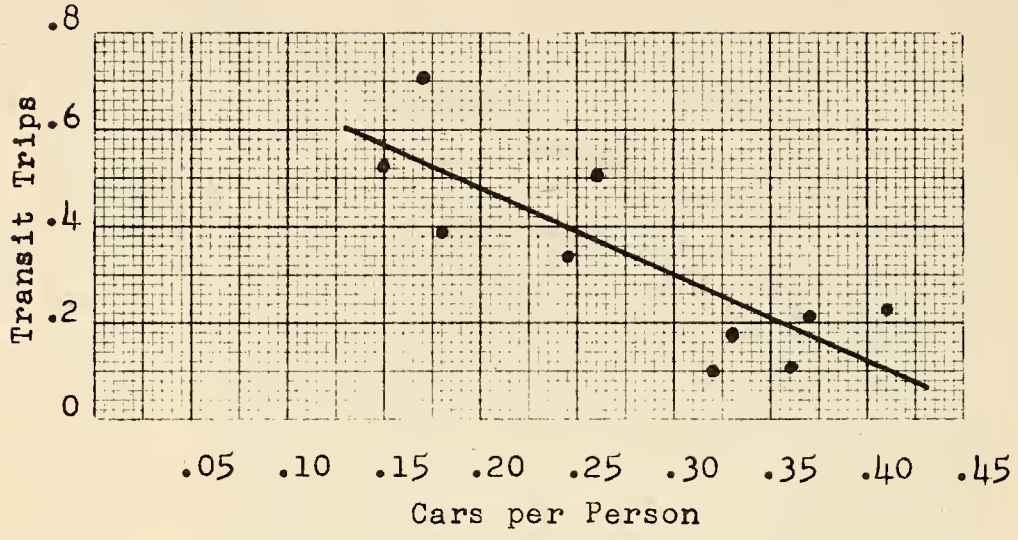
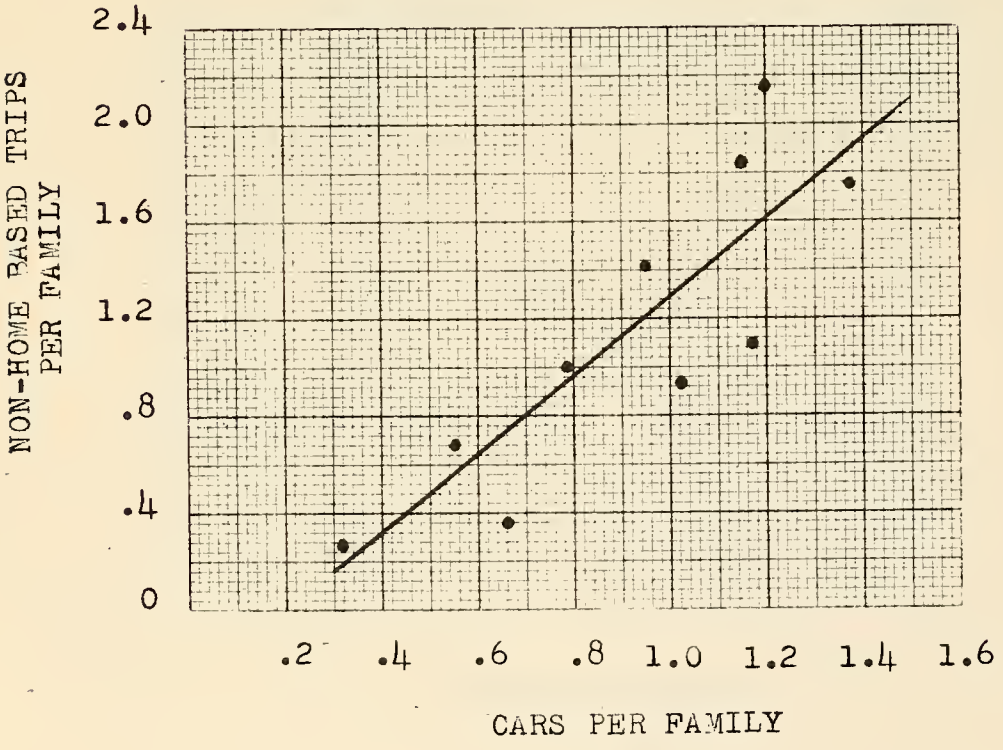


Chart # L

Daily Average of Non-Home Based Trips Per Family
Metropolitan Boston, 1958 - 1959



transit travel from one zone to another depending upon the type, cost and frequency of transit service available.

J. Non-Home Based Trips

Those trips by residents of any town made between origins and destinations other than the home also prove to increase as the average values of car ownership increase. The relationship shows a coefficient of correlation of .840 and a relative variation of 27.1%. The predicting equation is $Y = -.325 + 1.618 X$, where Y equals the average number of non-home based trips per family in any given zone and X equals the average value of cars owned per family. The regression line is shown on the opposite page.

The general pattern of travel behavior as expressed by the relationships and equations described above shows that families and areas of higher income contain the higher ratios of car ownership; and in turn produce greater numbers of daily vehicle trips per family.

The findings indicate that all types of trips are made more frequently each day as the average number of cars owned per family increases, except the number of work trips per family and the number of transit trips per family.

The areas of higher income, higher ratios of car ownership and greater daily trip production are the suburban cities and towns which must also contend with the development of new residential construction and population growth. The combination of greater travel per average family and constantly increasing numbers of families identify the suburban communities as the areas of greatest traffic growth in the near future and therefore the areas that must prepare to meet the heaviest part of the traffic onslaught.

The next sections of this report specify the magnitude of the growth of motor vehicle travel in many of the suburban communities. In most cases the expectations represent a major threat to the future of these suburban communities.

The nature and importance of this threat suggests strongly that these areas prepare in advance to handle the amounts of travel and traffic that will occur. This preparation should range from: advanced planning and right of way acquisition of major and secondary streets as well as expressways, to the investment for adequate off street parking in areas of high traffic generation, and to the carefully thought out designs for land development in each city and town through use of sub-division and zoning controls. In essence, suburban cities and towns must plan to give the automobile the space and the systems required for efficient movement and parking.

Most of the relationships described above are considered adequate to estimate the travel habits in each city and town of Metropolitan Boston with an assurance that the resultant figures are within the range of probable daily travel variations caused by the weather, special events and normal day to day and month to month fluctations. In the case of estimating total home based trips, work trips, total non-work trips and total automobile driver trips, the results are acceptable and within the expectations of the design of the sample. Estimates for the shopping, personal business

and recreation categories, are less accurate because of the great daily variation, but the results have been included in the following sections and provide a description of the magnitude of travel for various purposes.

THE BOSTON REGION MAP II

TRAFFIC ZONES

STUDIES OF URBAN TRANSPORTATION

SEMINAR RESEARCH BUREAU COLLEGE OF BUSINESS ADMINISTRATION

BOSTON COLLEGE January 1960

Findings III - Trip Production in Cities and Towns of Metropolitan Boston, 1959

The number of trips produced in each city and town (a traffic zone in the case of larger cities that have been subdivided or smaller towns that have been grouped to maintain more evenly sized areas) is summarized below. The figures represent the number of trips by residents of the zone during an average day. The amounts are results of the application of the predicting equations, and incorporate the same degree of accuracy of estimate mentioned in the previous section.

The map on the opposite page identifies the groupings and subdivisions of communities in the Boston Region that are the traffic zones created for this survey.

Table # 2

Seminar Research Bureau
Boston College

METROPOLITAN BOSTON TOTAL TRIP SUMMARY, 1958 - 1959

Total Daily Home-Based Trips to Work, Home and Nonwork for 100 Cities and Towns (Traffic Zones.)

Sector I - Northeast

ZONE	MUNICIPALITY	TO WORK TRIPS	TO HOME TRIPS	NONWORK TRIPS	TOTAL HOME-BASED TRIPS
101	E. Boston	14,630	31,946	14,244	60,820
102	Winthrop	6,268	14,138	8,878	29,284
103	Chelsea	11,427	25,430	12,159	49,016
104	Revere	12,134	29,427	16,533	58,094
105	Saugus	6,090	16,304	10,869	33,263
106	Lynn A	13,000	31,026	15,157	59,183
107	Lynn B, Nahant	17,852	44,091	29,855	91,798
108	Swampscott Marblehead	8,409	24,541	18,956	51,906
109	Salem	12,590	30,896	18,356	61,842
110	Peabody	8,749	23,002	15,216	46,967
111	Lynnfield	2,088	6,290	5,078	13,456
112	Danvers Topsfield Middleton	6,586	19,185	14,421	40,192
113	Beverly	9,814	26,110	18,061	53,985
114	Hamilton Wenham, Essex Ipswich	5,710	17,303	13,882	36,895
115	Gloucester Rockport	8,987	23,896	16,507	49,390
Sector I - Total		144,334	363,585	228,172	736,091

Sector II - Northwest

201	Charlestown	7,504	15,724	5,516	28,744
202	Cambridge A	14,843	35,031	16,907	66,781
203	Cambridge B	20,748	48,279	26,772	95,799
204	Somerville A	10,914	27,193	19,435	57,542
205	Somerville B	17,993	41,398	20,094	79,485
206	Everett	13,780	33,358	18,954	66,092
207	Malden	17,920	43,422	26,378	88,220
208	Medford	20,176	50,588	29,634	100,398

Table # 2 (continued)

ZONE	MUNICIPALITY	TO WORK TRIPS	TO HOME TRIPS	NONWORK TRIPS	TOTAL HOME-BASED TRIPS
209	Arlington	12,393	33,820	24,727	70,940
210	Belmont	8,957	23,789	15,857	48,603
211	Lexington	7,048	20,019	14,434	41,501
212	Winchester	5,789	15,817	10,811	32,417
213	Stoneham	4,882	13,258	9,015	27,155
214	Melrose	8,610	23,075	15,635	47,320
215	Wakefield	6,908	18,660	12,619	38,187
216	Reading	5,250	14,401	10,064	29,715
217	Woburn	8,427	21,695	13,642	43,764
218	Lincoln Concord, Acton Carlisle	6,000	18,707	15,118	39,825
219	Burlington Bedford	4,100	12,220	10,085	26,405
220	N. Reading Wilmington	5,438	15,001	10,422	30,861
Sector II - Total		207,680	525,955	326,119	1,059,754
Sector III - West					
301	Fens	6,800	13,140	6,260	26,200
302	Brighton	18,480	42,174	23,870	84,524
303	Brookline	18,470	46,842	28,321	93,633
304	Newton	27,750	76,154	51,661	155,565
305	Watertown	11,716	29,528	18,007	59,251
306	Waltham	15,167	40,001	26,156	81,324
307	Weston, Wayland	4,871	14,612	11,166	30,649
308	Wellesley	7,661	20,704	13,749	42,114
309	Needham, Dover	7,553	22,419	17,402	47,374
310	Natick	7,351	20,934	15,546	43,831
311	Sherborn Holliston Ashland	3,476	10,070	7,815	21,361
312	Framingham	12,719	34,514	23,444	70,677
313	Sudbury, Maynard	3,882	10,820	8,026	22,728
Sector III - Total		145,896	381,912	251,423	779,231
Sector IV - Southwest					
402	Roxbury A	17,460	35,039	13,068	65,567
403	Roxbury B	15,759	31,708	11,765	59,232
404	Jamaica Plain	11,830	27,885	16,159	55,874
405	Roslindale	9,636	23,491	12,315	45,442
406	W. Roxbury	8,925	20,868	11,296	41,089
407	Hyde Park	10,682	23,333	10,633	44,648
408	Dedham	6,822	19,136	13,703	39,661
409	Westwood	2,548	7,626	6,102	16,276
410	Norwood	6,732	17,714	11,866	36,312

Table # 2 (continued)

ZONE	MUNICIPALITY	TO WORK TRIPS	TO HOME TRIPS	NONWORK TRIPS	TOTAL HOME-BASED TRIPS
411	Walpole, Sharon	6,090	17,344	12,807	36,241
412	Medfield Millis, Medway Norfolk	4,059	11,607	9,202	24,868
413	Foxboro Mansfield	5,050	13,696	9,534	28,280
Sector IV - Total		105,593	249,447	138,450	493,490
Sector V - Southeast					
501	South Boston	17,675	36,232	13,965	67,872
502	Dorchester A	17,160	38,462	19,090	74,712
503	Dorchester B	14,040	33,033	17,459	64,532
504	Dorchester C	8,904	20,126	9,954	38,984
505	Dorchester D	14,700	33,885	18,000	66,585
506	Milton	7,960	21,623	14,651	44,234
507	Quincy	25,970	66,925	43,447	136,342
508	Canton, Avon Stoughton	8,477	23,170	16,547	48,194
509	Randolph Holbrook	8,407	22,273	13,871	44,551
510	Braintree	8,620	23,489	16,275	48,384
511	Weymouth	12,126	33,837	24,535	70,498
512	Hingham, Hull Cohasset	6,270	19,384	15,675	41,329
513	Scituate Norwell Marshfield	4,541	15,540	14,047	34,128
514	Hanover Whitman Rockland Abington	9,891	31,124	25,947	66,962
515	Brockton	19,410	51,150	35,066	105,626
516	Easton W. Bridgewater	3,599	10,696	8,228	22,523
517	E. Bridgewater Bridgewater Halifax	4,123	12,333	9,545	26,001
518	Hanson, Pembrook Duxbury	3,667	11,580	9,557	24,804
Sector V - Total		195,540	504,862	325,858	1,026,261
000-5 Downtown		30,564	75,222	43,270	149,256
Grand Total		829,607	2,100,984	1,313,292	4,243,883

Table # 3

Seminar Research Bureau
Boston College

METROPOLITAN BOSTON TRIP SUMMARY, 1958 - 1959

Total Daily Home-Based Trips by Nonwork Purpose for 100 Cities and Towns (Traffic Zones.)

Sector I - Northeast

ZONE	MUNICIPALITY	SHOPPING TRIPS	PERSONAL BUSINESS TRIPS	SOCIAL TRIPS
101	E. Boston	3,338	2,606	8,299
102	Winthrop	2,127	1,891	4,853
103	Chelsea	2,867	2,285	7,017
104	Revere	3,946	3,458	9,117
105	Saugus	2,627	2,447	5,788
106	Lynn A	3,641	3,291	8,215
107	Lynn B, Nahant	7,093	5,919	16,842
108	Swampscott Marblehead	4,597	4,378	9,971
109	Salem	4,381	3,839	10,122
110	Peabody	3,662	3,328	8,217
111	Lynnfield	1,234	1,185	2,654
112	Danvers Topsfield Middleton	3,501	3,353	7,553
113	Beverly	4,353	3,988	9,719
114	Hamilton Wenham, Essex Ipswich	3,377	3,260	7,232
115	Gloucester Rockport	3,973	3,651	8,873
Sector I - Total		54,717	48,879	124,472

Sector II- Northwest

201	Charlestown	1,288	963	3,270
202	Cambridge A	4,051	3,582	9,273
203	Cambridge B	6,336	5,175	15,260
204	Somerville A	4,619	3,887	10,928
205	Somerville B	4,777	4,052	11,249
206	Everett	4,524	3,965	10,452
207	Malden	6,307	5,537	14,533
208	Medford	7,107	6,385	16,122

Table # 3 (continued)

ZONE	MUNICIPALITY	SHOPPING TRIPS	PERSONAL BUSINESS TRIPS	SOCIAL TRIPS
209	Arlington	5,951	5,446	13,314
210	Belmont	3,829	3,565	8,453
211	Lexington	3,503	3,337	7,587
212	Winchester	2,621	2,476	5,703
213	Stoneham	2,180	2,038	4,792
214	Melrose	3,771	3,495	8,360
215	Wakefield	3,050	2,831	6,730
216	Reading	2,436	2,278	5,344
217	Woburn	3,283	3,005	7,345
218	Lincoln, Acton Carlisle, Concord	3,687	3,600	7,818
219	Burlington Bedford	2,445	2,310	5,320
220	N. Reading Wilmington	2,523	2,376	5,512
Sector II - Total		78,288	70,303	177,365
Sector III - West				
301	Fens	1,400	710	4,170
302	Brighton	5,610	4,400	13,882
303	Brookline	6,822	6,223	15,275
304	Newton	12,524	11,867	27,219
305	Watertown	4,326	3,891	9,778
306	Waltham	6,304	5,799	14,037
307	Weston, Wayland	2,724	2,669	5,763
308	Wellesley	3,333	3,158	7,244
309	Needham, Dover	4,229	4,062	9,094
310	Natick	3,769	3,550	8,218
311	Sherborn Holliston Ashland	1,894	1,795	4,117
312	Framingham	5,674	5,307	12,450
313	Sudbury, Maynard	1,941	1,814	4,266
Sector III - Total		60,550	55,245	135,513
Sector IV - Southwest				
402	Roxbury A	2,970	1,782	8,352
403	Roxbury B	2,692	1,698	7,405
404	Jamaica Plain	3,822	3,172	9,152
405	Roslindale	2,963	2,693	6,650
406	W. Roxbury	2,686	2,278	6,324
407	Hyde Park	2,499	1,960	6,183
408	Dedham	3,325	3,168	7,202
409	Westwood	1,484	1,426	3,188
410	Norwood	2,856	2,624	6,378

Table # 3 (continued)

ZONE	MUNCIPALITY	SHOPPING TRIPS	PERSONAL BUSINESS TRIPS	SOCIAL TRIPS
411	Walpole, Sharon	3,105	2,965	6,723
412	Medfield Millis, Medway Norfolk	2,222	2,069	4,905
413	Foxboro Mansfield	2,302	2,151	5,070
Sector IV - Total		32,926	27,986	77,532
Sector V - Southeast				
501	South Boston	3,202	2,082	8,697
502	Dorchester A	4,504	3,630	10,956
503	Dorchester B	4,160	3,549	9,763
504	Dorchester C	2,352	1,915	5,686
505	Dorchester D	4,260	3,480	10,260
506	Milton	3,552	3,345	7,745
507	Quincy	10,439	9,479	23,476
508	Canton, Avon Stoughton	3,999	3,726	8,812
509	Randolph Holbrook	3,362	3,186	7,308
510	Braintree	3,930	3,672	8,654
511	Weymouth	5,934	5,547	13,041
512	Hingham, Hull Cohasset	3,821	3,715	8,124
513	Scituate Norwell Marshfield	3,434	3,403	7,193
514	Hanover Whitman Rockland Abington	6,319	6,143	13,451
515	Brockton	8,425	7,614	19,005
516	Easton W. Bridgewater	19,99	1,925	4,296
517	E. Bridgewater Bridgewater Halifax	2,320	2,239	4,976
518	Hanson, Pembrook Duxbury	2,331	2,285	4,933
Sector V - Total		78,343	70,935	176,376
000-5	Downtown	10,356	9,196	23,686
Grand Total		315,180	282,544	714,944

STUDIES OF URBAN TRANSPORTATION

Table # 4

Seminar Research Bureau
Boston College

METROPOLITAN BOSTON TRIP SUMMARY, 1958 - 1959

Total Daily Home-Based Non-Driver and Auto Driver Trips
100 Cities and Towns (Traffic Zones.)

Sector I - Northeast			
ZONE	MUNICIPALITY	NON-DRIVER TRIPS	AUTO DRIVER TRIPS
101	E. Boston	32,624	22,051
102	Winthrop	13,115	16,174
103	Chelsea	25,559	19,382
104	Revere	27,204	29,518
105	Saugus	13,647	20,978
106	Lynn A	28,397	28,194
107	Lynn B, Nahant	41,624	50,456
108	Swampscott Marblehead	19,102	37,537
109	Salem	28,365	32,771
110	Peabody	19,834	28,530
111	Lynnfield	4,744	10,177
112	Danvers Topsfield Middleton	14,898	28,775
113	Beverly	22,195	34,107
114	Hamilton Wenham, Essex Ipswich	12,943	28,010
115	Gloucester Rockport	20,282	31,236
Sector I - Total		324,533	417,896
Sector II - Northwest			
201	Charlestown	16,430	8,114
202	Cambridge A	32,643	30,611
203	Cambridge B	47,230	44,017
204	Somerville A	25,415	33,159
205	Somerville B	39,841	34,594
206	Everett	30,823	33,839
207	Malden	40,212	47,272
208	Medford	45,238	54,660

Table # 4 (continued)

ZONE	MUNICIPALITY	NON-DRIVER TRIPS	AUTO DRIVER TRIPS
209	Arlington	28,416	46,573
210	Belmont	19,994	30,554
211	Lexington	15,886	28,621
121	Winchester	12,906	21,263
213	Stoneham	10,982	17,476
214	Melrose	19,398	29,936
215	Wakefield	15,602	24,261
216	Reading	11,828	19,540
217	Woburn	18,849	25,694
218	Lincoln, Acton Carlisle, Concord	13,631	30,918
219	Burlington Bedford	9,405	19,835
220	N. Reading Wilmington	12,233	20,391
Sector II - Total		466,962	601,328
Sector III - West			
301	Fens	16,090	5,740
302	Brighton	42,592	37,246
303	Brookline	41,117	53,214
304	Newton	61,938	101,934
305	Watertown	26,235	33,316
306	Waltham	34,186	49,621
307	Weston, Wayland	10,860	22,937
308	Wellesley	16,974	27,128
309	Needham, Dover	17,124	34,876
310	Natick	16,695	30,474
311	Sherborn Holliston Ashland	7,880	15,421
312	Framingham	28,557	45,520
313	Sudbury, Maynard	8,781	15,559
Sector III - Total		329,029	472,986
Sector IV - Southwest			
402	Roxbury A	39,582	14,742
403	Roxbury B	35,312	14,137
404	Jamaica Plain	26,936	27,014
405	Roslindale	21,155	23,089
406	W. Roxbury	19,924	19,948
407	Hyde Park	23,774	16,591
408	Dedham	15,258	27,171
409	Westwood	5,764	12,348

Table # 4 (continued)

ZONE	MUNICIPALITY	NON-DRIVER TRIPS	AUTO DRIVER TRIPS
410	Norwood	15,136	22,453
411	Walpole, Sharon	13,665	25,437
412	Medfield Millis, Medway Norfolk	9,310	17,730
413	Foxboro Mansfield	11,332	18,442
Sector IV - Total		237,148	238,502
Sector V - Southeast			
501	South Boston	39,917	17,395
502	Dorchester A	38,379	30,822
503	Dorchester B	31,421	30,199
504	Dorchester C	19,916	16,279
505	Dorchester D	33,255	29,595
506	Milton	17,746	28,720
507	Quincy	58,726	81,234
508	Canton, Avon Stoughton	19,099	31,938
509	Randolph Holbrook	18,543	27,370
510	Braintree	19,420	31,480
511	Weymouth	27,541	47,562
512	Hingham, Hull Cohasset	14,216	31,957
513	Scituate Norwell Marshfield	10,387	26,183
514	Hanover Whitman Rockland Abington	22,573	52,828
515	Brockton	44,195	65,227
516	Easton W. Bridgewater	8,158	16,535
517	E. Bridgewater Bridgewater Halifax	9,345	19,239
518	Hanson, Pembrook Duxbury	8,314	19,631
Sector V - Total		440,701	604,194
000-5	Downtown	68,400	78,616
Grand Total		1,866,773	2,413,522

Findings IV - Trip Production in Metropolitan Boston, 1980

Projections of the amount and type of travel to take place in Metropolitan Boston in future years depends upon many factors. Enough of these factors can be identified and predicted to allow reasonable forecasts of travel and transport needs. Changes in population of the region will cause changes in the amount of travel. Changes in economic conditions, family characteristics, housing development trends and patterns of industrial and commercial development will all exert influences upon how many trips are to be made. The availability and condition of transportation facilities will have a particularly strong influence upon trip production. All of these factors that influence travel are interdependent. For example, the pattern of residential and commercial development will be influenced by the amount and type of transportation or communication facilities. Population changes are partly dependent upon the economic vitality of the region. Automobile ownership, which appears to be most strongly related to travel habits, is conditioned by, or is a reflection of, the availability of transportation facilities, the patterns of residential and commercial development, as well as the general economic outlook.

The complexity of these many related factors, and the inability to foresee the future make it impossible to scientifically and accurately forecast the amount of travel that will occur in 20 years. However, reasonable estimates

are possible that can establish the future range of possibilities. At least the magnitude of future potentials can be specifically identified to aid decisions which must be made now. Estimates of future travel require assumptions regarding the future and these estimates are only as good as the assumptions on which they are based.

The process of estimating and predicting urban travel and transportation conditions is no different than the process of planning for other future situations. It entails using the best data and methods of analysis and making the most reasonable assumptions possible, and modifying these imputs through constant up-dating as new and more advanced information becomes available. Reasonable estimates of 1980 conditions make an unchallenged contribution to the process of planning and designing facilities that are intended to serve the community for many decades. But the major dollar saving contributions will be realized if the data, assumptions and procedures are continually improved to allow the most accurate measures of future needs.

The following projections of travel in Metropolitan Boston assume a general continuation of post war economic and travel trends. It is assumed that the national and regional economy will be characteristized by a relatively stable rate of growth in income levels, and that there will not be a major depression. It is expected that as a result

Metropolitan Boston will continue to grow and receive its share of wealth, jobs and population. It is also expected that residential growth will be primarily but not entirely in the outlying suburban areas with low density single family homes continuing as the dominant type of dwelling. Commercial and industrial development is expected to seek both downtown and decentralized sites as has been the case in the more recent past.

Population Projections

During the past decade the population of Metropolitan Boston (100 cities and towns) has increased at a slower rate than the country as a whole. The population of the 100 cities and towns has grown from 2,606,202 in 1950 to about 2,865,000 in 1959. This growth represents an average increase of about 1% per year.

Population changes have been composed primarily of growth in suburban areas and stagnation or decline in core cities. The inner core of 14 cities and towns (the Metropolitan Transit Authority District) has had a stable population of about 1,500,000 since 1950. The remaining 86 cities and towns of the region have experienced a total increase in population during the period from 900,000 in 1950 to about 1,400,000 persons in 1959.

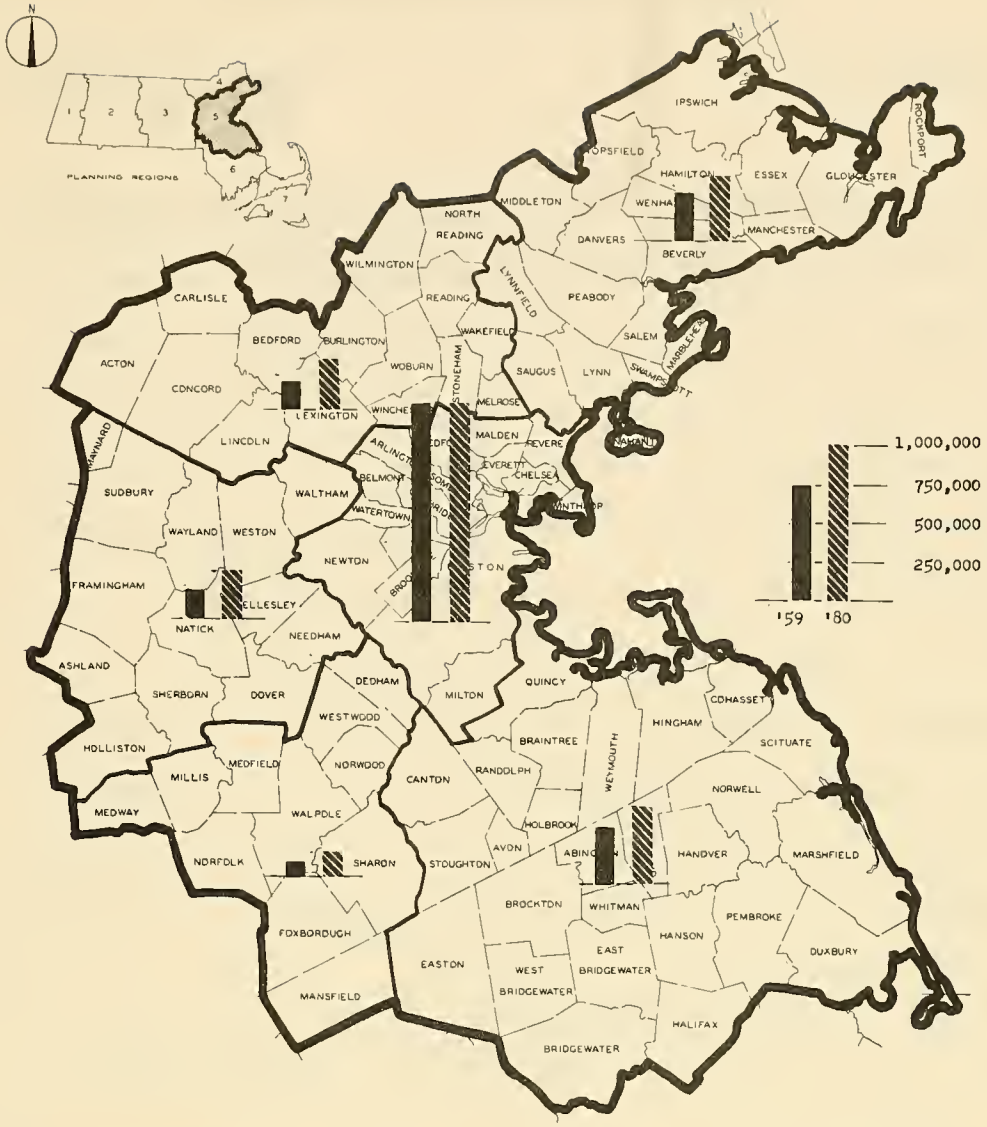
The trends of the past decade are expected to continue in the future. The Boston Metropolitan Area population will continue to increase but at a slower rate than expected for

the country as a whole. The number of persons in the 100 cities and towns is expected to increase by 575,000 - 600,000 to provide a 1980 total population of nearly 3,500,000. This represents a 20% increase over 1959 population, or an average of about 1% per year.

The additional population is distributed to the cities and towns in accordance with a continuation of recent new development tendencies. Some judgement was applied to compensate for the influence of new highways that are planned for the intervening years. The resultant estimated 1980 population for each city and town is shown in Appendix II, and summarized by groups of zones on map III on the opposite page.

Car Ownership

The average car ownership ratio of all of Regional Boston is now .91 cars per family. Increasing incomes, shorter work hours and better transportation facilities all encourage more families to own more than one car. We expect that car ownership in the Boston Region will continue to increase and eventually approach levels already reached in some other American cities, particularly those in the West. By 1980, it is believed that car ownership will reach a maximum level of 1.40 cars per family or an average of .48



THE BOSTON REGION MAP III

POPULATION 1959 - 1980

STUDIES OF URBAN TRANSPORTATION

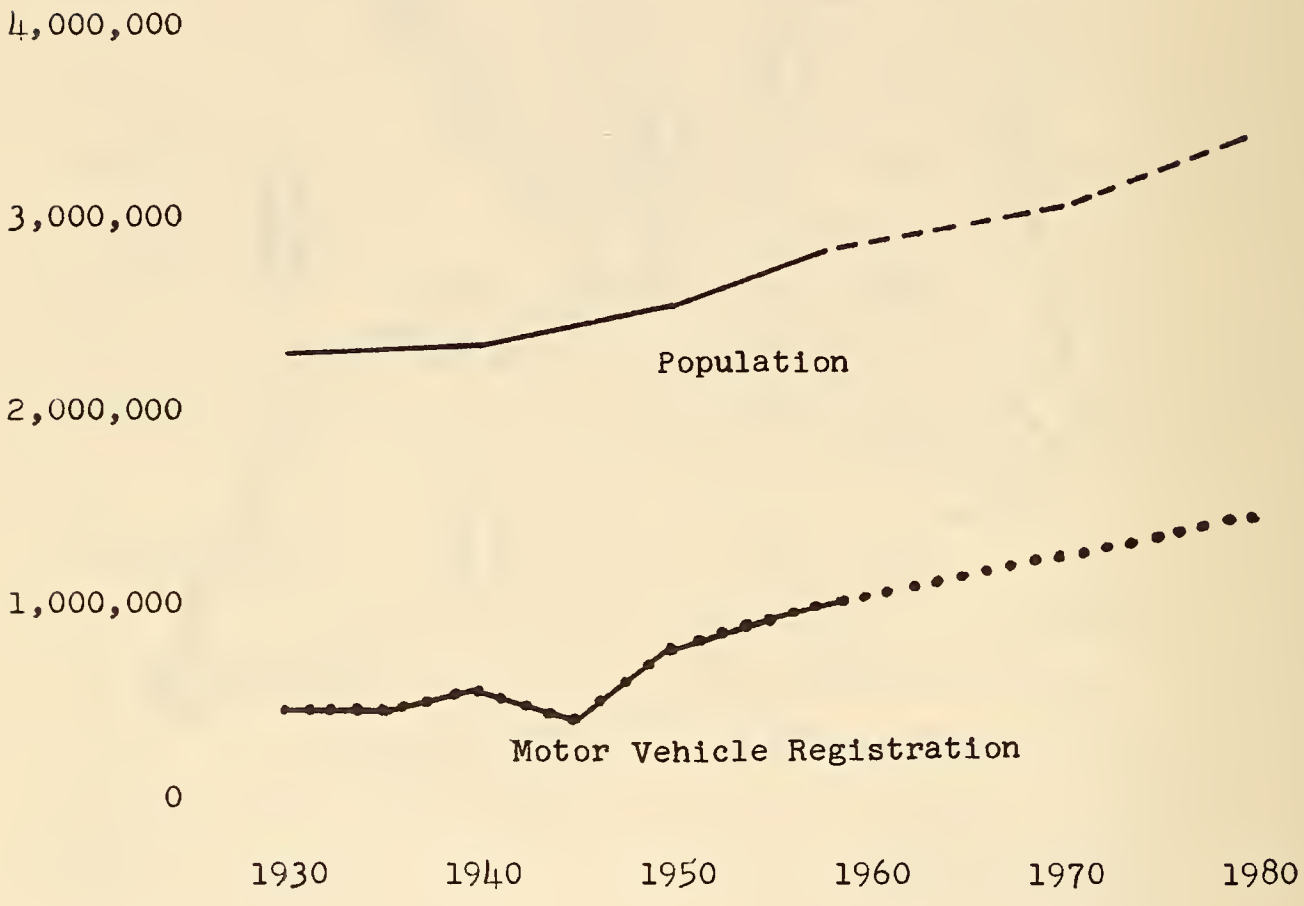
SEMINAR RESEARCH BUREAU COLLEGE OF BUSINESS ADMINISTRATION

BOSTON COLLEGE January 1960

Chart # M

Seminar Research Bureau
Boston College

Population and Motor Vehicle Registration
Metropolitan Boston, 1930, 1959, and 1980 (Estimated)
(100 Cities and Towns)



cars per person. A metropolitan wide ratio of 1.4 cars per family is considered to be a maximum value that probably will not be exceeded. But it is considered a level that can be reached eventually; if not by 1975 - 1980, then soon thereafter. Thus, it has been used as a metropolitan wide maximum control value. An increase in car ownership from .91 in 1959 to 1.40 in 1980 is an increase of 55% for the entire metropolitan area.

The simple product of a greater metropolitan-wide car ownership ratio of 1.4 by 1980, combined with the expected new population, is many additional automobiles. The Metropolitan Area of 100 cities and towns now contains 760,000 passenger cars registered and in use. By 1980 there will be some 1,410,000 passenger cars on the streets of the region. Many of the additional 650,000 cars will be the second car to a family. It can be expected that a maximum of 40 - 50% of the families of Regional Boston will have two cars.

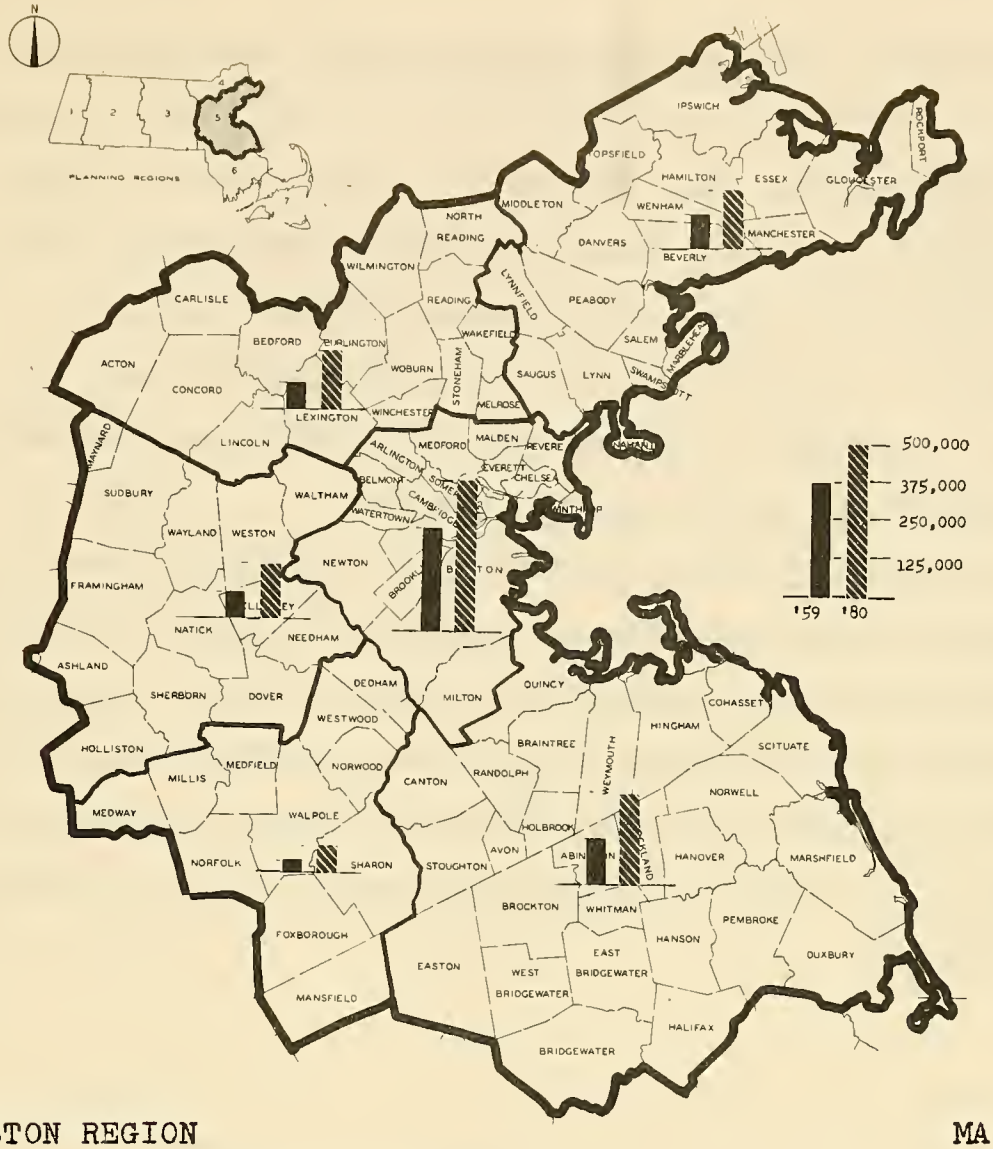
Although all sections will increase in average car ownership, it cannot be expected that the metropolitan-wide average increase will occur evenly throughout the region. Some traffic zones, particularly those containing very high density apartment buildings closer to the center of the city and that are better served by mass transit, and have little space for

automobile parking and circulation, will experience smaller than average increases in car ownership. On the other hand suburban areas will increase at greater than average rates.

Two alternative methods have been used to determine future car ownership ratios for each city and town within the limits established for the entire metropolitan area. The first alternative increases the average ownership ratio in each zone by a percentage that is proportioned to the existing car ownership in each zone. The second alternative increases the ratio by using two factors with equal weight: (a) a percentage increase in proportion to the existing ownership data as in the first alternative and (b) a standard percentage increase.

Both of these alternatives are controlled to maintain a metropolitan average of 1.4 cars per family. And both alternatives allow smaller than average increases to occur in zones with existing low ownership ratios and greater than average increases in zones with existing high ratios. In no case has the future car ownership ratio in any city town or zone been allowed to exceed an average value of 2.0 cars per family.

In the judgement of the staff, the application of these alternatives presents a realistic view of future car ownership patterns throughout Metropolitan Boston. The methods involved and the resultant values of average car ownership for each city and town are more satisfactory than estimates that apply



THE BOSTON REGION MAP IV

AUTOMOBILE OWNERSHIP 1959 - 1980

STUDIES OF URBAN TRANSPORTATION

SEMINAR RESEARCH BUREAU COLLEGE OF BUSINESS ADMINISTRATION

BOSTON COLLEGE January 1960

a standard percentage increase to every zone, estimates that raise car ownership in every zone to a 1.4 level, or making no adjustment at all. While it is true that the values indicated will not prove to be exactly the case in every zone in 1980 the estimates nevertheless are expected to be generally realized at that time provided that there are no major disturbances to economic or population development and continued transportation development.

Chart # M graphically shows the past and expected trend of population and car ownership in the 100 city and town Boston Region from 1930 to 1980. Appendix II lists the 1959 and 1980 population and car ownership values for each city and town as computed by the Seminar Research Bureau. Map # IV shows the general pattern of 1959 and 1980 car ownership.

TRAVEL IN METROPOLITAN BOSTON - 1980

Those socio-economic and travel relationships that produced the statistically most accurate predicting equations for 1959 have been used to estimate the amount and type of travel in 1980. At the outset it is recognized that these equations are valid representations of 1959 conditions. Their application to a 1980 society will involve errors of estimate reflecting fundamental, but as of now unidentifiable, changes in our ways of living and travelling. However there is currently no better method of estimating available. Other estimating processes consist of merely projecting past trends of gasoline sales, automobile registrations, or average car mileage statistics to establish estimates of yearly percentage increases that are applied equally to all sections of the region.

The process that has been used for these predictions is much more sensitive to the basic social and economic peculiarities of the metropolitan area; to the particular conditions that characterize each city and town of the region, and to the changes that occur almost continually in the social and economic structure of the area and its many parts.

The results of the application of the predicting equations to the metropolitan area as a whole and to each city and town are shown in the following tables.

Table # 5

Seminar Research Bureau
Boston College

Comparison of Metropolitan Boston Travel Characteristics
1959 - 1980

	Average Value Per Family		Total Trips	
CHARACTERISTIC	1959	1980	1959	1980
Total Trips	6.403	8.171	5,286,573	8,211,144
Nonhome Based	1.189	1.940	981,686	1,949,531
Home Based	5.214	6.231	4,304,887	6,261,613
To Home	2.593	2.952	2,140,885	2,966,503
To Work	1.049	1.003	866,096	1,007,928
To Non-work	1.572	2.276	1,297,906	2,287,182
Shopping	0.377	0.554	311,266	556,722
Personal Business	0.337	0.536	278,241	538,633
Social	0.858	1.185	708,399	1,190,822
Auto Driver	2.879	4.597	2,377,018	4,619,585
Non Driver	2.335	1.634	1,927,869	1,650,000

The calculations indicate many travel features that will have a great effect upon transportation policies and construction during the intervening years.

Amount of Travel - 1980

The total number of trips to be produced by residents of the Metropolitan Region is expected to increase by 55% between 1959 and 1980. This will raise the daily total from 5,280,000 in 1959 to 8,200,000 in 1980 by all modes of travel and for all purposes. Over 6,260,000 of these total trips will either start or end at the home; i.e. home based trips. The remaining 1,950,000 trips that are expected to occur daily are non-home based and comprise 24% of the total trips in 1980 (compared to 18.5% of the total trips in 1959).

The total number of trips increase from an average of 6.4 trips per family in 1959 to almost 8.2 trips per family in 1980.

Purpose of Travel-1980

The composition of travel by purpose is expected to change considerably by 1980. The expected increases in car ownership throughout the region and the construction of new expressways will encourage more mid-day travel by non-working members of the family. Greater amounts of mid-day non-work travel now occur in cities and towns that contain high average ratios of car ownership. As other zones obtain increasing amounts of cars per family the number of non-work trips will

increase. The following table compares the purpose distribution of 1959 with that estimated for 1980. The figures represent the percentage of total home-based trips undertaken for each of the purposes indicated.

Table # 6

Distribution of Purposes of 1959 and 1980 Home-Based Daily Trips, Boston Metropolitan Region

Purpose of Trip	1959	1980
To Work	20.1%	16.1%
For Shopping	7.2%	8.9%
For Business & Recreation	6.5%	8.6%
For Social, Civic, Religious and Education	16.5%	19.0%
To Home	49.7%	47.4%
	100.0%	100.0%

Work trips are expected to decrease as a percentage of total travel (but not as a total amount, see Table 4). Shopping, business, recreation, social, civic, religious and education trips in vehicles are expected to increase both relatively and absolutely. The implications of this changing composition of trip purposes are that transportation facilities, particularly highways and expressways will be used more heavily during the off-peak hours. Peak hour travel will increase, but not as much as travel during other hours, thus becoming a smaller proportion of total travel.

Mode of Travel

The 1980 figures indicate that future automobile travel and future highway requirements will increase substantially. The number of automobile driver trips (equivalent to the number of automobile vehicle trips) is expected to almost double by 1980. Non-driver trips actually decrease slightly due to expected increased ownership of motor vehicles. It is estimated that automobile driver travel will increase from almost 2,400,000 daily trips in 1959 to over 4,600,000 daily trips in 1980. On a per family basis this type of trip averages 2.9 in 1959 and is expected to become 4.6 in 1980.

The 1959 - 1980 increase in total daily travel amounts to almost 3,000,000 trips per day. Over 2,200,000 of this increase is composed of home-based auto driver trips. The remainder are non-home based trips which are also primarily made in automobiles. In effect the total increase in daily travel by residents of the Metropolitan Region will be made in automobiles.

Non-driver trips, those made by passengers in automobiles, taxis, trucks and mass transportation, are expected to decrease slightly as a total and on a per family basis. Total daily non-driver trips decrease from 1,928,000 in 1959 to about 1,650,000 in 1980. The average per family ratios decrease from 2.335 daily trips per family in 1959 to 1.634 daily trips per family in 1980.

As before, this expected pattern reflects the influence of more cars owned by the residents of the region.

The pattern of many more auto driver trips and fewer auto passenger trips causes the average occupancy of cars to become much less in 1980 than in 1959. The average in 1980 is calculated to be 1.25 persons in each car compared to a value of 1.45 in 1959.

The results of the above computations indicate the nature of the threat which increased automobile use will have upon mass transportation use. The computations warn that mass transit use threatens to decrease by 50% of its total 1959 traffic volume by 1980. However, these calculations reflect recent trends and current conditions and thereby describe what will naturally occur if the automobile use is unrestricted. In many instances the opportunity to use other than mass transportation will not occur. The outstanding example is travel to Downtown Boston where there is a distinct limitation upon the number of vehicles that can be accommodated. In special situations of this type the regional expectation must be modified by what is possible and economically practical. The actual number of future transit riders throughout the Boston Region will be primarily determined by such influencing factors as transit fares, the number of new transit extensions, and the amount of growth and new jobs in the Downtown Area.

The increase expected in automobile driver (and vehicle) trips will continue to increase the need for highways in Metropolitan Boston. Twice as much motor vehicle traffic volume creates the general need for almost twice as much capacity of all types of highway facilities. It cannot be specifically determined at this phase of the study where and what kind of facilities there must be. This can be established only after the destination patterns of these trips have been identified and analyzed. It can only be crudely estimated that the increased volumes expected by 1980 will create the need for additional regional expressways and major highways as well as many miles of local streets.

Tables # 7 & 8 indicate the trips estimated to occur on an average day in each city and town of the Region. Analysis of this regional pattern of 1980 travel indicates that the amount of automobile driver trips increases in varying degrees from sector to sector and zone to zone.

Those zones located just beyond Route 128 are expected to experience the greatest increase in daily automobile travel. This is because these communities will experience the greatest increase in population and car ownership and as a result the number of automobile trips will increase from between 140% to over 200%. See Maps # II and # VI.

The total travel in cities and towns of the present MTA District is estimated to increase only 15% while total daily home-based trips in the outer 86 suburban towns show an average increase of 75%.

Similarly, the number of automobile trips produced within the MTA district increase 56.8% , while those produced by residents of the outlying 86 cities and towns are expected to increase 117.2%. On a sector to sector basis the increase is expected to be rather evenly distributed. The Western Sector of the Metropolitan Area shows the greatest increase in automobile trips, 103.2%. The Northeastern, Northwestern and Southwestern Sectors all show increases of between 85 - 90% and the Southeastern Sector is expected to experience a 97.8% increase.

These estimated changes in the amount of total home-based trips are the result of trips produced by residents of the 100 cities and towns of the region. The location of the other end of the trip is to be identified by the mechanics of Phase II of this study. A great proportion of the trips will have destinations not too distant from the point of origin. Therefore, it is reasonable to expect that a greater proportion of future transportation expenditures for streets and highways will be required to serve the suburban communities.

These estimates of 1980 travel can be compared with estimates presented in Coverdale and Colpitts "Report on Traffic Studies for the Boston Metropolitan Area."* That report estimates that motor vehicle travel in Metropolitan Boston will increase by 80% between 1955 and 1975 because of "natural" or "normal" reasons, and by an additional 45% because of "induced" reasons. The resultant total estimate indicates that 1975 motor vehicle travel will be 2.619 times as great as 1955 travel.

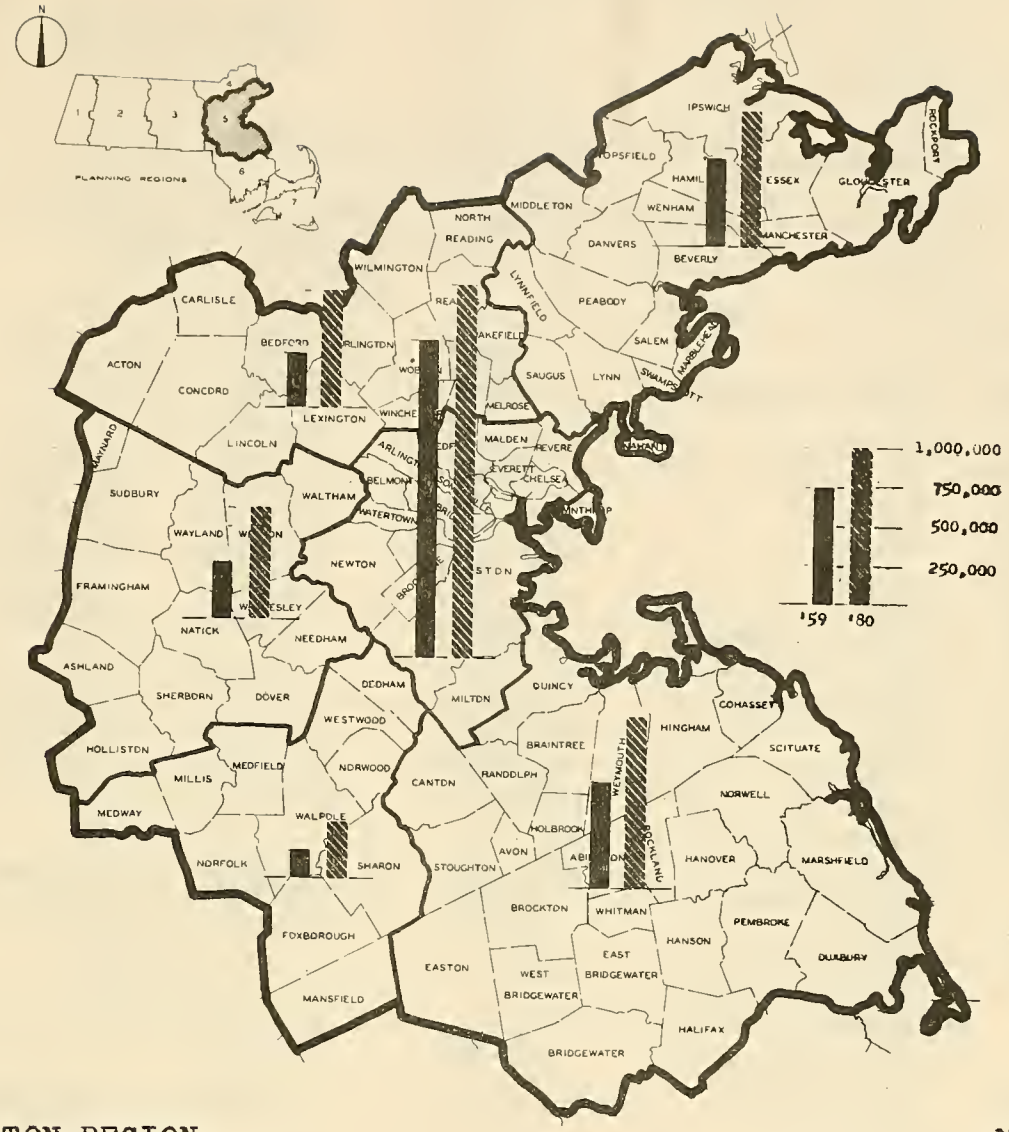
The estimates contained herein foresee a smaller increase than indicated by the above-mentioned report. It is estimated that 1980 travel will be about 2.00 times that of 1959 as a maximum. A greater increase is difficult to imagine unless substantially greater population increases occur than those expected in our population study of the Boston Region.

Further detailed growth comparisons with the Coverdale and Colpitts Report on a zonal basis is impossible because that report applied the 2.619 growth factor equally to all zones of the region. Herein the 1959 - 1980 travel growth factor varies with each zone because of differing population and socio-economic conditions in each zone.

In conclusion, the expected increases in daily travel throughout the Boston Region of 100 cities and towns presents a major financial and design problem to be solved by the

*July 22, 1957

governments of the metropolitan area. There seems to be little alternative but to invest the funds to supply reasonable facilities for the growing demands of urban mobility. However, the magnitude of the problem, as it makes itself felt in our current traffic problems and as it promises to grow according to the numbers stated in previous sections of this report, indicates clearly that there is little room for mistakes or unplanned investment.



THE BOSTON REGION MAP V

TOTAL TRIP FREQUENCY 1959 - 1980

Number of Daily Person-Trips by Residents

STUDIES OF URBAN TRANSPORTATION

SEMINAR RESEARCH BUREAU COLLEGE OF BUSINESS ADMINISTRATION

BOSTON COLLEGE January 1960

Table # 7

Seminar Research Bureau
Boston College

METROPOLITAN BOSTON TOTAL TRIP ESTIMATES, 1980

Total Daily Home-Based Trips to Work, Home and Non-Work for 100 Cities and Towns (Traffic Zones.)

ZONE	MUNICIPALITY	TO WORK TRIPS	NONWORK TRIPS	TO WORK TRIPS	TOTAL HOME-BASED TRIPS
Sector I - Northeast					
101	E. Boston	13,000	16,000	31,000	61,000
102	Winthrop	7,000	14,000	19,000	40,000
103	Chelsea	10,000	13,000-	24,000	47,000
104	Revere	14,000	25,000	37,000	76,000
105	Saugus	9,000	21,000	27,000	57,000
106	Lynn A	12,000	18,000	30,000	60,000
107	Lynn B, Nahant	17,000	36,000	46,000	99,000
108	Swampscott Marblehead	12,000	39,000	43,000	93,000
109	Salem	13,000	25,000	36,000	75,000
110	Peabody	14,000	31,000	41,000	86,000
111	Lynnfield	4,000	14,000	15,000	32,000
112	Danvers Topsfield Middleton	13,000	40,000	45,000	98,000
113	Beverly	13,000	31,000	39,000	83,000
114	Hamilton Wenham, Essex Ipswich Manchester	11,000	37,000	39,000	86,000
115	Gloucester Rockport	11,000	27,000	34,000	72,000
Sector I - Total		173,000	387,000	505,000	1,065,000
Sector II - Northwest					
201	Charlestown	5,000-	4,000	10,000	19,000
202	Cambridge A	14,000	21,000	36,000	71,000
203	Cambridge B	20,000	32,000	49,000	101,000
204	Somerville A	10,000	23,000	29,000	62,000
205	Somerville B	17,000	24,000	42,000	84,000
206	Everett	14,000	24,000	37,000	75,000
207	Malden	19,000	37,000	52,000	108,000
208	Medford	21,000	40,000	58,000	119,000
209	Arlington	16,000	44,000	51,000	111,000
210	Belmont	10,000	25,000	32,000	68,000
211	Lexington	13,000	38,000	44,000	95,000

Table # 7 (continued)

ZONE	MUNICIPALITY	TO WORK TRIPS	NONWORK TRIPS	TO HOME TRIPS	TOTAL HOME-BASED TRIPS
212	Winchester	9,000	22,000	28,000	59,000
213	Stoneham	8,000	20,000	25,000	52,000
214	Melrose	12,000	29,000	36,000	76,000
215	Wakefield	10,000	24,000	30,000	63,000
216	Reading	9,000	23,000	28,000	60,000
217	Woburn	13,000	27,000	37,000	77,000
218	Lincoln, Acton Carlisle, Concord	11,000	39,000	41,000	91,000
219	Burlington Bedford	14,000	46,000	48,000	108,000
220	N. Reading Wilmington	9,000	24,000	29,000	61,000
Sector II - Total		253,000	565,000	741,000	1,559,000
Sector III - West					
301	Fens	6,000	7,000	13,000	25,000
302	Brighton	18,000	28,000	43,000	88,000
303	Brookline	22,000	46,000	64,000	131,000
304	Newton	31,000	81,000	99,499	211,000
305	Watertown	14,000	27,000	38,000	79,000
306	Waltham	21,000	48,000	62,000	130,000
307	Weston, Wayland	10,000	34,000	37,000	81,000
308	Wellesley	9,000	23,000	29,000	62,000
309	Needham, Dover	15,000	47,000	52,000	113,000
310	Natick, Sherborn	12,000	36,000	41,000	88,000
311	Sherborn, Holliston Ashland	7,000	23,000	26,000	56,000
312	Framingham	21,000	53,000	66,000	141,000
313	Sudbury, Maynard	7,000	18,000	21,000	46,000
Sector III - Total		193,000	470,000	590,000	1,253,000
Sector IV- Southwest					
402	Roxbury A	14,000	12,000	29,000	56,000
403	Roxbury B	13,000	12,000	28,000	52,000
404	Jamaica Plain	11,000	20,000	29,000	60,000
405	Roslindale	9,000	16,000	25,000	51,000
406	W. Roxbury	10,000	16,000	52,000	52,000
407	Hyde Park	11,000	13,000	25,000	48,000
408	Dedham	8,000	23,000	27,000	59,000
409	Westwood	6,000	19,000	20,000	45,000
410	Norwood	10,000	25,000	32,000	67,000
411	Walpole, Sharon	10,000	29,000	33,000	72,000
412	Medfield Millis, Medway Norfolk	8,000	25,000	28,000	61,000
413	Foxboro Mansfield	8,000	21,000	25,000	54,000
Sector Iv - Total		120,000	231,000	328,000	678,000

Table # 7 (continued)

ZONE	MUNICIPALITY	TO WORK TRIPS	NONWORK TRIPS	TO HOME TRIPS	TOTAL HOME-BASED TRIPS
Sector V - Southeast					
501	S. Boston	15,000	14,000	32,000	61,000
502	Dorchester A	16,000	23,000	40,000	79,000
503	Dorchester B	14,000	21,000	35,000	70,000
504	Dorchester C	9,000	12,000	22,000	43,000
505	Dorchester D	14,000	21,000	33,000	68,000
506	Milton	12,000	31,000	38,000	81,000
507	Quincy	29,000	64,000	83,000	176,000
508	Canton, Avon Stoughton	14,000	37,000	45,000	96,000
509	Randolph Holbrook	12,000	28,000	37,000	77,000
510	Braintree	13,000	33,000	41,000	87,000
511	Weymouth	18,000	49,000	58,000	125,000
512	Hingham, Hull Cohasset	12,000	44,000	46,000	102,000
513	Scituate, Norwell Marshfield	10,000	42,000	42,000	94,000
514	Hanover Rockland Abington Whitman	15,000	57,000	58,000	129,000
515	Brockton	19,000	45,000	56,000	119,000
516	Easton W. Bridgewater	5,000	17,000	19,000	42,000
517	E. Bridgewater Bridgewater Halifax	7,000	22,000	24,000	53,000
518	Hanson, Pembrook Duxbury	7,000	25,000	25,000	57,000
Sector V- Total		241,000	585,000	733,000	1,558,000
000-5	Downtown	57,000	52,000	49,000	159,000
Grand Total		1,009,000	2291,000	2973,000	6272,000

Table # 8

Seminar Research Bureau
Boston College

METROPOLITAN BOSTON AUTO DRIVER TRIP ESTIMATES, 1980

Total Daily Home-Based Auto Driver Trips for 100 Cities and Towns (Traffic Zones)

Sector I - Northeast

ZONE	MUNICIPALITY	AUTO DRIVER TRIPS	PERCENT INCREASE FROM 1959
101	E. Boston	27,000	22.4
102	Winthrop	27,000	66.9
103	Chelsea	23,000	18.6
104	Revere	48,000	62.6
105	Saugus	44,000	109.7
106	Lynn A	36,000	27.7
107	Lynn B, Nahant	66,000	30.8
108	Swampscott Marblehead	81,000	115.8
109	Salem	49,000	49.5
110	Peabody	63,000	120.8
111	Lynnfield	29,000	185.0
112	Danvers Topsfield Middleton	85,000	195.4
113	Beverly	63,000	84.7
114	Hamilton Wenham, Essex Ipswich Manchester	79,000	182.0
115	Gloucester Rockport	56,000	79.3
Sector I - Total		777,000	85.9

Sector II - Northwest

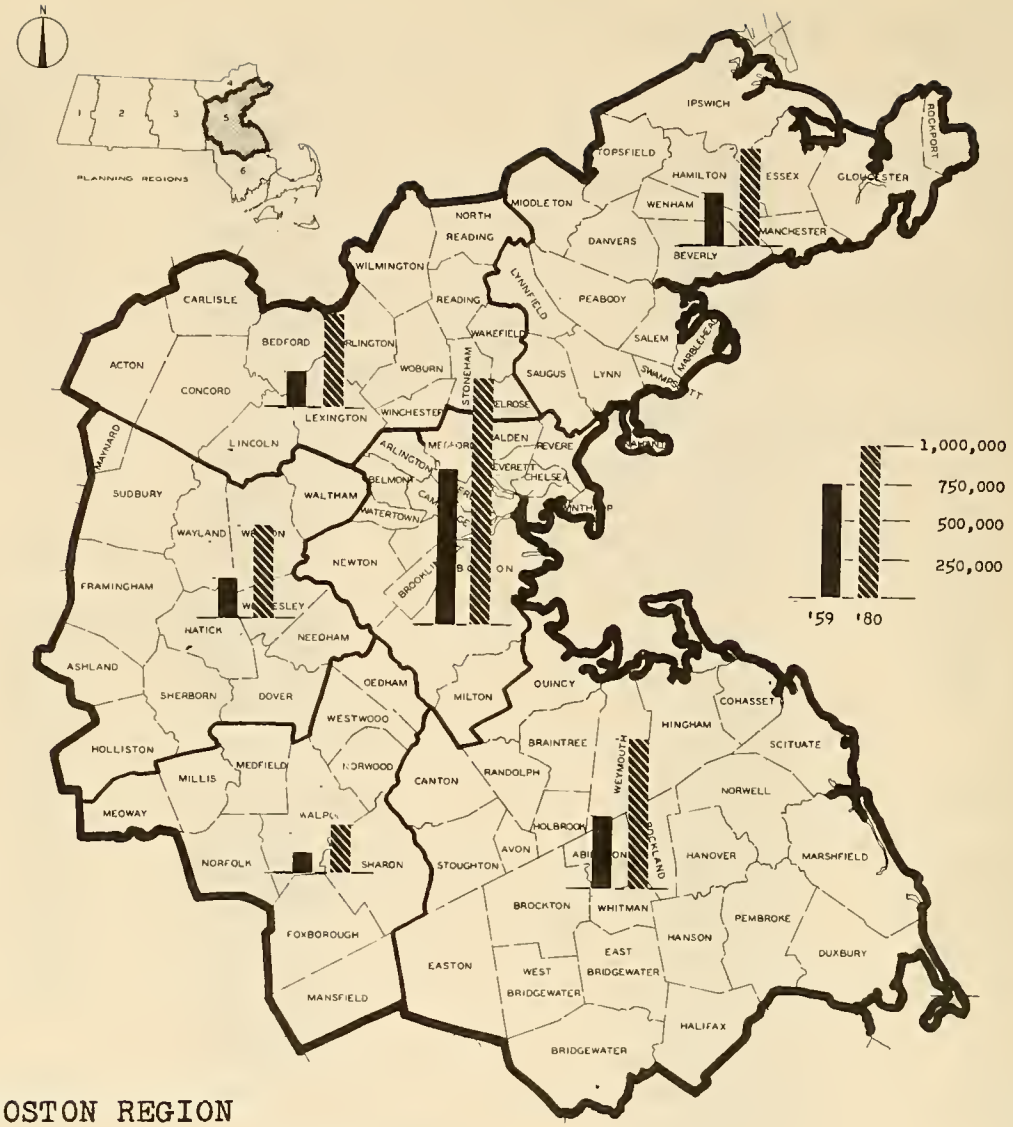
201	Charlestown	7,000	-13.7
202	Cambridge A	41,000	33.9
203	Cambridge B	57,000	29.5
204	Somerville A	43,000	29.7
205	Somerville B	46,000	33.0
206	Everett	47,000	38.9
207	Malden	71,000	50.2
208	Medford	80,000	46.4
209	Arlington	89,000	91.1
210	Belmont	52,000	70.2
211	Lexington	80,000	179.5

Table # 8 (continued)

ZONE	MUNICIPALITY	AUTO DRIVER TRIPS	PERCENT INCREASE FROM 1959
212	Winchester	47,000	121.0
213	Stoneham	41,000	134.6
214	Melrose	59,000	97.1
215	Wakefield	49,000	102.0
216	Reading	48,000	145.6
217	Woburn	56,000	117.9
218	Lincoln, Concord Acton, Carlisle	85,000	174.9
219	Burlington Bedford	97,000	389.0
220	N. Reading Wilmington	49,000	140.3
Sector II - Total		1,141,000	89.7
Sector III - West			
301	Fens	7,000	22.0
302	Brighton	48,000	28.9
303	Brookline	92,000	72.9
304	Newton	170,000	66.8
305	Watertown	54,000	62.1
306	Waltham	97,000	95.5
307	Weston, Wayland	74,000	222.6
308	Wellesley	49,000	80.6
309	Needham, Dover	100,000	186.7
310	Natick	74,000	142.8
311	Sherborn Holliston Ashland	49,000	217.7
312	Framingham	111,000	143.8
313	Sudbury, Maynard	38,000	144.2
Sector III - Total		963,000	103.6
Sector IV - Southwest			
402	Roxbury A	16,000	8.5
403	Roxbury B	16,000	13.2
404	Jamaica Plain	36,000	33.3
405	Roslindale	32,000	38.6
406	W. Roxbury	31,000	59.4
407	Hyde Park	23,000	38.6
408	Dedham	49,000	80.3
409	Westwood	41,000	234.7
410	Norwood	50,000	122.7
411	Walpole, Sharon	61,000	139.8
412	Medfield, Millis Norfolk, Medway	52,000	193.3

Table # 8 (continued)

ZONE	MUNICIPALITY	AUTO DRIVER TRIPS	PERSENT INCREASE FROM 1959
413	Foxboro Mansfield	43,000	133.2
Sector IV - Total		450,000	88.7
Sector V - Southeast			
501	South Boston	20,000	15.0
502	Dorchester A	40,000	29.8
503	Dorchester B	40,000	32.5
504	Dorchester C	22,000	35.1
505	Dorchester D	37,000	25.0
506	Milton	64,000	122.8
507	Quincy	128,000	57.6
508	Canton Stoughton Avon	77,000	141.1
509	Randolph Holbrook	58,000	111.9
510	Braintree	69,000	119.2
511	Weymouth	102,000	114.5
512	Hingham, Hull Cohasset	95,000	197.3
513	Scituate Norwell Marshfield	92,000	251.4
514	Hanover Rockland Abington Whitman	122,000	130.9
515-516	Brockton Easton W. Bridgewater	90,000 37,000	40.0 123.8
517	E. Bridgewater Bridgewater Halifax	47,000	144.3
518	Hanson Pembrook Duxbury	54,000	175.1
Sector V - Total		1,195,000	97.8
000-5	Downtown	207,000	163.3
Grand Total		4,630,000	91.8



THE BOSTON REGION MAP VI

TOTAL AUTOMOBILE TRIPS 1959 - 1980

Number of Daily Automobile Trips by Residents

STUDIES OF URBAN TRANSPORTATION

SEMINAR RESEARCH BUREAU COLLEGE OF BUSINESS ADMINISTRATION

BOSTON COLLEGE January 1960

APPENDIXES

STUDIES OF URBAN TRANSPORTATION

Seminar Research Bureau
College of Business Administration
BOSTON COLLEGE

TRANSPORTATION QUESTIONNAIRE Interviewer:_____

No. _____ Date:_____Time:_____

1) Interview Address:_____Telephone No._____

2) Type of Dwelling Structure:_____

3) Date of Travel:_____Day of Week of Travel:_____

4) How many people live here?.....____

5) How many are 5 years or older?.....____

6) How many passenger cars are owned by people living at this address?_____

Household Information

Person Number	Person Identification Relationship	Occupation & Industry
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		

Comments:

STUDIES OF URBAN TRANSPORTATION - Seminar Research Bureau - BOSTON COLLEGE

TRIP INFORMATION	TRIP 1	TRIP 2	TRIP 3	TRIP 4	TRIP 5
7. Person Number					
8. If Interviewed	Yes____No____	Yes____No____	Yes____No____	Yes____No____	Yes____No____
9. Where did Trip Start (Address)					
10. What time did Trip START	____A.M.____P.M.	____A.M.____P.M.	____A.M.____P.M.	____A.M.____P.M.	____A.M.____P.M.
11. Terminal Time at Trip START	_____Min.	_____Min.	_____Min.	_____Min.	_____Min.
12. Where did Trip END (Address)					
13. What time did Trip END	____A.M.____P.M.	____A.M.____P.M.	____A.M.____P.M.	____A.M.____P.M.	____A.M.____P.M.
14. Terminal Time at Trip END	_____Min.	_____Min.	_____Min.	_____Min.	_____Min.
15. Mode of travel					
16. Purpose of trip					

STUDIES OF URBAN TRANSPORTATION

Table # 9

Seminar Research Bureau
Boston College

METROPOLITAN BOSTON POPULATION AND CAR OWNERSHIP 1959 - 1980

Distribution by 100 Cities and Towns (Traffic Zones.)

Sector I - Northeast		POPULATION*		AVERAGE CAR OWNERSHIP	
ZONE	MUNICIPALITY	1959	1980	1959	1980
101	E. Boston	44,200	41,000	.56	.69
102	Winthrop	18,000	21,000	.89	1.21
103	Chelsea	35,000	31,000	.60	.74
104	Revere	37,100	43,000	.83	1.11
105	Saugus	18,700	27,000	1.12	1.62
106	Lynn A	37,000	33,000	.96	1.33
107	Lynn B, Nahant	60,600	57,000	.70	.90
108	Swampscott Marblehead	26,800	39,000	1.26	1.90
109	Salem	39,200	41,000	.83	1.11
110	Peabody	27,500	43,000	.99	1.38
111	Lynnfield	6,700	13,000	1.34	2.00
112	Danvers Topsfield Middleton	20,600	41,000	1.31	2.00
113	Beverly	31,000	40,000	1.02	1.44
114	Hamilton Wenham, Essex Ipswich Manchester	18,100	34,000	1.39	1.95
115	Gloucester Rockport	28,300	35,000	1.03	1.46
Sector I - Total		448,900	538,000		
Sector II - Northwest					
201	Charlestown	21,600	14,000	.50	.60
202	Cambridge A	43,000	40,000	.87	1.17
203	Cambridge B	66,000	62,000	.65	.82
204	Somerville A	37,300	35,000	.72	.93
205	Somerville B	53,400	50,000	.74	.96
206	Everett	42,100	42,000	.83	1.11
207	Malden	55,500	59,000	.84	1.12
208	Medford	61,500	63,000	.93	1.27
209	Arlington	40,400	53,000	1.01	1.42
210	Belmont	27,400	32,000	1.11	1.60
211	Lexington	21,800	41,000	1.27	1.91
212	Winchester	17,600	26,000	1.22	1.82

Table # 9 (continued)

ZONE	MUNICIPALITY	POPULATION* 1959	POPULATION* 1980	AVERAGE CAR OWNERSHIP 1959	AVERAGE CAR OWNERSHIP 1980
213	Stoneham	15,100	24,000	1.14	1.66
214	Melrose	26,800	36,000	1.08	1.55
215	Wakefield	21,500	30,000	1.10	1.58
216	Reading	16,300	27,000	1.15	1,68
217	Woburn	25,700	39,000	1.01	1.42
218	Lincoln, Acton Carlisle, Concord	19,000	34,000	1.50	2.00
219	Burlington Bedford	13,500	45,000	1.22	1.82
220	N. Reading Wilmington	16,800	27,000	1.19	1.76
Sector II - Total		642,300	780,000		
Sector III - West					
301	Fens	24,000	22,000	.25	.30
302	Brighton	60,700	57,000	.57	.70
303	Brookline	55,800	67,000	1.00	1.40
304	Newton	84,200	94,000	1.24	1.86
305	Watertown	35,900	41,000	.94	1.29
306	Waltham	47,000	64,000	1.04	1.47
307	Weston, Wayland	14,800	31,000	1.54	2.00
308	Wellesley	22,900	28,000	1.24	1.86
309	Needham, Dover	23,900	46,000	1.34	2.00
310	Natick	23,300	39,000	1.20	1.78
311	Sherborn Holliston Ashland	11,100	24,000	1.24	1.86
312	Framingham	39,200	65,000	1.15	1.68
313	Sudbury, Maynard	12,300	21,000	1.14	1.66
Sector III - Total		454,900	598,00		
Sector IV - Southwest					
402	Roxbury A	54,800	45,000	.32	.36
403	Roxbury B	48,500	41,000	.35	.40
404	Jamaica Plain	37,800	36,000	.68	.86
405	Roslindale	27,900	27,000	.99	1.38
406	W. Roxbury	27,300	31,000	.74	.96
407	Hyde Park	32,300	32,000	.57	.70
408	Dedham	20,900	25,000	1.27	1.91
409	Westwood	8,100	18,000	1.35	2.00
410	Norwood	20,900	33,000	1.03	1.46
411	Walpole, Sharon	18,900	31,000	1.28	1.94
412	Medfield, Millis Norfolk, Medway	13,400	25,000	1.13	1.64

Table # 9 (continued)		POPULATION*		AVERAGE CAR OWNERSHIP	
ZONE	MUNICIPALITY	1959	1980	1959	1980
413	Foxboro Mansfield	15,700	25,000	1.13	1.64
Sector IV - Total		326,500	370,000		
Sector V - Southeast					
501	South Boston	54,900	47,000	.37	.42
502	Dorchester A	52,600	50,000	.62	.77
503	Dorchester B	42,700	41,000	.75	.98
504	Dorchester C	27,200	27,000	.64	.80
505	Dorchester D	46,000	42,000	.65	.82
506	Milton	24,200	37,000	1.20	1.78
507	Quincy	80,600	88,000	.98	1.36
508	Canton, Avon Stoughton	26,600	44,000	1.12	1.62
509	Randolph Holbrook	24,700	36,000	1.24	1.86
510	Braintree	26,800	40,000	1.13	1.64
511	Weymouth	38,500	56,000	1.14	1.66
512	Hingham, Hull Cohasset	19,800	39,000	1.47	2.00
513	Scituate, Norwell Marshfield	14,700	34,000	1.52	2.00
514	Hanover, Whitman Rockland Abington	31,800	48,000	1.46	2.00
515	Brockton	62,100	60,000	.96	1.33
516	Easton W. Bridgewater	11,300	17,000	1.36	2.00
517	E. Bridgewater Bridgewater Halifax	13,000	21,000	1.38	2.00
518	Hanson Pembrook Duxbury	11,600	21,000	1.54	2.00
Sector V - Total		609,100	746,000		
000 - 5 Downtown		93,000	86,000	.88	1.19
Grand Total		2,574,700	3,118,000		

*Based on Persons five years of age and older.